Document Number
WOO3235

LORAL
Western Development Labs

COMBAT VEHICLE COMMAND & CONTROL (92) INNOVATIVE TRAINING METHODS

RESEARCH PRODUCT 1 (FINAL)

Catalogue Of Training Tools For Use In Distributed Interactive Simulation (DIS) Environments

Submitted By:
Loral Systems Company
ADST Program Office
Orlando, Fl

Prepared For:
United States Army
Simulation, Training & Instrumentation Command
Orlando, Fl

In Response To:
Contract N61339-91-D-0001
Delivery Order D006
CDRL Item A00F

30 July 1993

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (*Leave blank*)

2. REPORT DATE
July 1993

3. REPORT TYPE AND DATES COVERED
Final 9/91 to 7/93

4. TITLE AND SUBTITLE
Catalog of Training Tools for Use in Distributed Interactive Simulation (DIS) Environments

5. FUNDING NUMBERS
N61339-91
D-0001/0006
63007A
795
3206
C10

6. AUTHOR(S)
Atwood, N K., Winsch, B.J., Quinkert, K.A., and Heiden, C.K.

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
BDM International, Inc.
1801 Randolph Rd. S.E.
Albuquerque, NM 87106

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Army Research Institute
Field Unit at Fort Knox
Fort Knox, KY 40121-5620

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES
Contracting Officer's Representative, Dr. Kathleen A. Quinkert

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for Public Release; distribution is unlimited

12b. DISTRIBUTION CODE
A

13. ABSTRACT (*Maximum 200 words*)

This report catalogues training tools for use in Distributed Interactive Simulation (DIS) environments. It is intended as a reference document for users of DIS facilities and for planners of new simulation-based training facilities. The report describes the background and context in which these training tools were developed, and the capabilities and applications of tools developed to enhance simulation-based training in three functional areas. These areas include: (a) techniques for structuring simulation-based exercises; (b) strategies for eliciting and capturing Command, Control and Communications (C3) performance; and (c) approaches for demonstration, presentation and analysis.

14. SUBJECT TERMS
Distributed Interactive Simulation (DIS), Simulation-Based Training
Performance Measures, Simulation

15. NUMBER OF PAGES
80

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	Unlimited

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18
298-102

Research Product ____

CATALOG OF TRAINING TOOLS
FOR USE IN DISTRIBUTED INTERACTIVE SIMULATION (DIS) ENVIRONMENTS

Nancy K. Atwood,
Beverly J. Winsch
BDM Federal, Inc.

Kathleen A. Quinkert
U.S. Army Research Institute

MG Charles K. Heiden
U.S. Army (Rtd.)

Field Unit at Fort Knox, Kentucky
Barbara A. Black, Chief

Training Research Division
Jack H. Hiller, Director

Accesion For		
NTIS CRA&I	☒	
DTIC TAB	☒	
Unannounced	☐	
Justification		
By		
Distribution /		
Availability Codes		
Dist	Avail and / or Special	
A-1		

U.S. Army Research Institute for the Behavioral and Social Sciences
5001 Eisenhower Avenue, Alexandria, Virginia 22333-5600

Office, Deputy Chief of Staff for Personnel
Department of the Army

July 1993

Army Project Number Future Battlefield Conditions

Approved for public release; distribution is unlimited

FOREWORD

The U.S. Army Research Institute (ARI) is charged with conducting basic and applied behavioral and social research that will contribute to the Army's capability to meet the soldier performance challenges of today and tomorrow. As part of ARI's training research program, the objective of the Future Battlefield Conditions team at Fort Knox is to enhance soldier preparedness by identifying future battlefield conditions and developing training methods that assure effective soldier performance under these conditions.

As the Army moves toward the greater use of simulation environments for training, particularly distributed interactive simulation (DIS) environments, tools are needed to conduct training exercises efficiently and effectively. This product provides a catalog of training tools developed by the Future Battlefield Conditions team at Fort Knox for use in a DIS environment. They have been refined and used with success in the Mounted Warfare Test Bed (MWTB) facility. This catalog is presented as a reference document for users of DIS facilities to acquaint them with specific methods which may be appropriate for their particular requirement. It is also intended to offer ideas to the planners of new DIS facilities which they may wish to incorporate into their design and development process.

ARI's research on training requirements and methods for future automated C3 systems is supported by the Memorandum of Agreement (MOA) between USARI-Knox and the Tank Automotive Command (TACOM) on Combat Vehicle Command and Control (CVCC) dated 22 March 1989 and the MOA between USARI-Knox and the U.S. Army Armor Center (USAARMC) and Fort Knox titled Research in Future Battlefield Conditions, 12 April 1989.

The results of this effort were briefed to the Commanding General, Fort Knox; the Director, Mounted Warfighting Battle Space Laboratory; the Deputy Chief of Staff, U.S. Armor School; the Commanding General, Training and Doctrine Command (TRADOC) and the Deputy Chief of Staff Training, TRADOC.

EDGAR M. JOHNSON
Technical Director

ACKNOWLEDGMENTS

The training tools described in this Research Product have been developed through the contributions of several organizations and a large number of individuals within these organizations. Technical guidance was provided by Dr. Barbara Black, Chief of the Army Research Institute's Fort Knox Field Unit, Dr. Kathleen Quinkert, Team Leader of the Future Battlefield Conditions (FBC) Team, and Dr. Carl Lickteig and Mr. Gary Elliott of the FBC Team. While the individuals are too numerous to mention, contractor support was provided by a number of organizations including BDM Federal, Inc., BBN Systems and Technologies, Inc., Loral, Decision Research Corporation, Microanalysis and Design, and Universal Energy Systems.

In describing the training tools presented here, narrative has been drawn with some editing from previous reports and manuals where appropriate. This approach was taken to ensure clarity and consistency and reflects the full knowledge and agreement of all authors.

CATALOG OF TRAINING TOOLS FOR USE IN DISTRIBUTED INTERACTIVE SIMULATION (DIS) ENVIRONMENTS

CONTENTS

LIST OF FIGURES

LIST OF TABLES

Catalog of Training Tools
For Use In Distributed Interactive
Simulation (DIS) Environments

Introduction

This Research Product describes training tools developed by the U.S. Army Research Institute Field Unit at Fort Knox (ARI-Knox) for use in a program of ongoing research by the Future Battlefield Conditions (FBC) Team. In some cases, these training tools constitute new training-oriented applications of existing simulation-based hardware and software capabilities. In other cases, these training tools represent new training developments for use within a simulation-based training environment.

A major thrust of the FBC Team's research program has been the identification of conditions likely to be encountered on the future battlefield and the specification of training requirements. This research has been conducted using advanced simulation technology. This technology, referred to as Distributed Interactive Simulation (DIS), allows soldiers to participate in training exercises through interactive combat vehicle simulators engaged in a simulated battlefield environment. This product describes specific techniques, strategies, and approaches which have been used with success and refined over the past five years as part of the FBC research program conducted in the Mounted Warfare Test Bed (MWTB) facility at Fort Knox, Kentucky.

The catalog has two main purposes. First, it is intended to serve as a reference document for users of DIS facilities which they can consult during the planning process to acquaint themselves with tools used with success in previous training and evaluation efforts. We anticipate that, in some cases, users may wish to adopt specific tools for their particular application; in other cases, the tools described here may inform and guide their planning of productive approaches and strategies tailored to their specific requirement. Second, the catalog is intended to offer ideas to planners of DIS facilities. As the use of simulation within the military expands and new facilities are built (such as the Army's Close Combat Tactical Trainer [CCTT]), we expect that planners will wish to examine tools used productively in other facilities in the design and development process.

The tools described in this catalog were designed primarily for use in training within the DIS environment; however, their utility applies to the broader range of DIS applications currently being conducted and envisioned for the future. These additional applications include test and evaluation of concepts, prototypes and emerging systems as well as studies of emerging doctrine, organizations and special issues. Thus, the intended audience for this Research Product includes trainers and training developers, as well as members of the combat development, doctrine development, test and evaluation, and studies and analysis communities.

Organization of the Research Product

This research product is organized into four major sections. The remainder of this section describes the background and context within which the tools presented in subsequent sections were developed. The three remaining sections describe sets of tools to support and enhance functions within the DIS environment. These three functional areas, corresponding to the three following sections, focus on: (a) techniques for structuring simulation-based exercises, (b) strategies for eliciting and capturing Command, Control, and Communications (C3) performance and (c) approaches for demonstration, presentation and analysis. Each of these sections and the descriptions of the tools within are intended to stand as independent references for users and planners of DIS environments and applications.

Background

The FBC Team has been charged with conducting research to forecast conditions on the future battlefield and to develop training methods to prepare soldiers to perform effectively under these conditions. The following discussion is intended to provide a brief overview of the nature of training requirements anticipated in the near future and the increasing prominence of simulation-based training as a strategy for addressing these requirements. This discussion is followed by a short introduction to the context in which the tools described in the catalog were developed. It focuses on two features of the context that are particularly important for understanding the genesis of these tools: (a) the substantive focus of the ARI-Knox research program, and (b) the DIS environment in which the research was conducted.

Emerging Training Requirements. The U.S. Army has institutional mechanisms in place for identifying training requirements. These requirements emerge from two primary sources: (a) examinations of past performance or "lessons learned" to identify areas requiring attention and (b) projections of future trends and their implications for training requirements.

The principal Army agency charged with examining lessons learned is the Center for Army Lessons Learned (CALL) at Fort Leavenworth, Kansas. A recent report published by the General Accounting Office (GAO) in 1991 summarized the common training shortfalls identified by CALL as part of a larger study of land usage (GAO, 1991). Requirements for improved performance focused on the following primary areas: (a) battlefield planning by commanders and their staffs, (b) use of intelligence data in developing plans of operations (intelligence preparation of the battlefield), (c) conduct of reconnaissance and counter reconnaissance, (d) maintenance of communications, and (e) conduct of rehearsals. Follow-up interviews of key Army leaders by GAO staff

suggested that many believed that the key to addressing these areas is increased emphasis on individual and small unit training.

While several Army agencies have charters to examine future requirements, the Department of the Army's overall view of future training requirements is well characterized in a draft pamphlet currently under coordination by the Army's Training and Doctrine Command as Draft TRADOC PAM 525-5B (Department of the Army, 1991b). This pamphlet recognizes the unprecedented changes which the Army is facing including downsizing of the force, the budget on which it depends, and available land for maneuver and ranges. At the same time, the Army is fielding high technology devices and weapon systems that enhance lethality on the battlefield but demand: (a) considerably greater command and control skills from leaders; (b) more precise, complex performance from soldiers; and (c) greater space for training. The global environment and the changing nature of the threat from a U.S. - Soviet balance of power to a multipolar world order with new centers of regional power further complicate the situation. This threat calls for versatile forces which can perform their missions under a variety of conditions and circumstances, can insert units to carry out contingency operations and can operate in conjunction with coalition forces.

The Draft TRADOC PAM 525-5B calls for training as a cornerstone for developing and maintaining a smaller Army capable of effectively accomplishing its mission and countering the threats to U.S. interests. It is based on a concept for AirLand Operations for a Strategic Army which describes how Army forces will operate as the land component of military power in joint, combined and interagency operations in the future. TRADOC recognizes tough, realistic training as a prerequisite for successful implementation of this strategic concept. TRADOC leaders expect the principles of training inherent in the Army's capstone training doctrine manual, FM 25-100 (Department of the Army, 1988a), to remain valid and to drive evolving tactics, techniques, and procedures (see Table 1). This approach will be supplemented by the Combined Arms Training Strategy (CATS) currently under development

Table 1

Training Principles from FM 25-100

PRINCIPLES OF TRAINING
Train as Combined Arms and Service Teams
Train as You Fight
Use Appropriate Doctrine
Use Performance-Oriented Training
Train to Challenge
Train to Sustain Proficiency
Train Using Multi-echelon Techniques
Train to Maintain
Make Commanders the Primary Trainers

by each proponent school (Coordinating Draft, TC 17-12-2). CATS will serve as a training and resource management tool to "squeeze every bit of value from every training event and program" to meet the challenging training requirements of the future.

The Armor community has formulated the Armor 2000 strategy and the Armor portion of CATS (U.S. Army Armor Center, 1990) to articulate projected requirements for the Armor force and strategies for delivering training to meet these requirements. The Armor 2000 strategy views training as the cornerstone of mobility and lethality of the Armor force. Given an era of resource constraints, Armor is moving to a device and simulation-based training strategy coupled with live-fire and maneuver field exercises. This training strategy emphasizes realistic simulations; combined and integrated simulators and modern training devices which can be used to train soldiers, vehicle crews, and units on nearly all required battlefield tasks under demanding conditions.

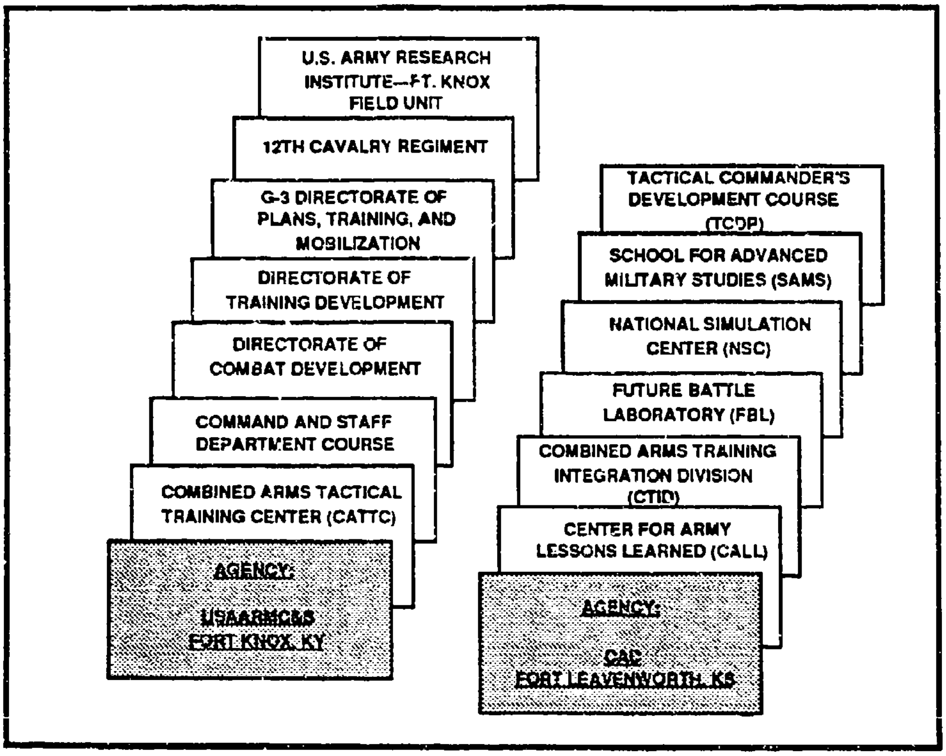
As the Armor community fields increasingly complex technology, the importance of training in general and simulation-based training in particular is expected to increase. For example, the M1A2 tank will contain an automated command and control device referred to as the "Intervehicular Information System" (IVIS). Among other capabilities, IVIS will allow tank commanders to send and receive messages digitally. Such technology will levy new training requirements, not only for device operation skills, but also for effective information management under conditions of overload and integration of device usage into a tactical environment.

To elaborate and further understand published training requirements, a series of interviews were conducted with representatives of key Army organizations at the U.S. Army Armor Center and School (USAARMC&S) Fort Knox, and the Combined Arms Command (CAC) located at Fort Leavenworth, Kansas during the Spring of 1992. These interviews were structured to gather participants' views of current training needs and emerging training requirements, particularly in the area of command, control, and communications. The C3 area has been recognized as a particularly important area in published reports of training requirements and one which lends itself well to simulation-based training. As such, C3 is a focal area of research interest for the FBC Team. (Copies of interview protocols can be found in Appendixes A and B.)

Organizations participating in the interviews are identified in Table 2. While we have not identified specific individuals to maintain privacy and confidentiality, most interviewees were field grade officers or above or senior civilians at the rank of GS-12 or above. In some cases, one representative from an organization was interviewed. In other cases, group interviews were conducted generally with two or three individuals, although two interview sessions numbered six participants due to the high level of interest by the organization in participating in the interview.

Table 2

Participating Agencies: Training Requirements Interviews



A content analysis of the interviews was conducted to identify training requirements viewed by interviewees as critical to developing or maintaining high performing soldiers and units under projected future battlefield conditions. The following discussion highlights key findings emerging from the interviews.

Table 3 summarizes key findings emerging from the interviews conducted at Fort Knox. These training requirements fell into four main categories as shown in Table 3. The first category included more general mission-oriented requirements centering on operating effectively as a member of a combined arms team with the capability to respond to a variety of contingency force doctrines. The remaining three categories corresponded to the three Battlefield Operating Systems (BOSs) targeted for focus in the interviews: (a) Command, Control and Communications, (b) Intelligence, and (c) Maneuver. The three primary requirements associated with C3 (shown in Table 3) center on training to accommodate the use of automated C3 devices while maintaining manual skills. This requirement is consistent with conceptual training requirements associated with the fielding of new technologies, such as the IVIS to be housed within the MIA2 tank. Requirements derived from the interviews associated with the Intelligence BOS focused on intelligence preparation of the

battlefield (IPB) and reconnaissance. These areas were also identified as priority intelligence training requirements in a GAO study of training conducted as part of a large study of land usage (GAO, 1991). Finally, training requirements in the maneuver area reflect two sets of related requirements. The first is the need for disciplined, well coordinated performance as recognized by published training requirements calling for rehearsals. The second is the versatility of performance across conditions required by emerging doctrine and future anticipated mission requirements.

Table 3

Critical Training Requirements: Fort Knox Interviews

CATEGORY	KEY FINDINGS
MISSION	Operate as part of a combined arms team Respond to doctrines of contingency forces
C3	Use voice and digital communications effectively Manage incoming information appropriately Maintain manual skills reinforcing automated C3 devices (e.g., map reading)
INTEL	Conduct of Intelligence Preparation of the Battlefield (IPB) Conduct of reconnaisance activities Conduct of leader's reconnaissance
MANEUVER	Synchronize forces Operate effectively as crews Perform according to Tactical SOP Decrease fratricides React to mass casualties Perform under adverse weather conditions Navigate on varied terrain under different conditions

Findings derived from the interviews conducted at Fort Leavenworth are highlighted in Table 4. The main focus of these training requirements is on C3 at battalion level. More specifically, interviewees underscored the need to concentrate on the fundamental skills of C3, to structure training experiences so that battalion staff members learn to work together as an integrated battle staff, and to ensure that battalion staff learn how to coordinate combat assets effectively to produce battle synchronization. The central role of learning how to conduct effective rehearsals was also stressed in these interviews. The importance of rehearsals has been repeatedly identified as a training lesson learned and is documented in the GAO report mentioned earlier (GAO, 1991). Finally, two training requirements requiring balance between technological and human considerations emerged from the Fort Leavenworth interviews. A technology-oriented training requirement emerged for the incorporation of C3 devices into training exercises. The concept here was to ensure that units and their leaders learn to incorporate effective use of their C3

devices into their procedures prior to deployment. The other training requirement centered on the importance of training command skills and the need to explicitly teach leadership skills under stress. More specifically, interviewees made the point that C3 training must balance human and technological considerations so that commanders capitalize on technology tools while honing their skills to lead effectively.

Table 4

Critical Training Requirements: Fort Leavenworth Interviews

CATEGORY	KEY FINDINGS
C^3	Train C^3 fundamental skills to standard
	Operate as an integrated battle staff at Bn
	Coordinate combat assets effectively to produce battle synchronization
	Conduct effective rehearsals
	Integrate operation of automated C^3 devices into established procedures
	Command and lead soldiers under stress balancing human and technological considerations

In summary, the training requirements facing the Army today are challenging. These requirements derive from a variety of sources including a reduced force structure, a more austere budget, less maneuver area for field exercises, and a regionalized and diverse threat. Units must be prepared to operate as a combined arms force, perform a variety of contingency missions under diverse conditions, and capitalize on emerging technology to fight and win. These circumstances dictate new training requirements such as an increased capability to manage large amounts of information effectively (given the emergence of digital communications) and underscore the importance of recognized training requirements such as needs for skilled planning, careful preparation and rehearsal and disciplined performance of well practiced tactical procedures.

<u>The Growing Prominence of Simulation-Based Training</u>. The need to counter a wide variety of diverse threats at a time of manpower and budget reduction has placed increased priority on training generally and on simulation as a strategy for delivering training in particular. Simulation offers a cost-effective

strategy for providing training on a widespread basis under a variety of conditions. Furthermore, simulation-based training is well suited to addressing the training requirements underscored in our interviews which are also receiving increasing attention in the Army community.

For example, a keynote speaker at the 1992 Armor Conference, COL Molinari, Director of Training Development (DOTD) at Fort Knox, offered seven compelling reasons for training using simulation. They centered on the capabilities of simulation, especially DIS, to provide:

1. Greater frequency of training events;
2. More in-depth analyses of tasks;
3. Better training of collective tasks;
4. Objective feedback;
5. Realistic scenarios;
6. Training efficiency;
7. Training standardization; and
8. Training under more varied conditions.

It is also instructive to note that our interviews at Fort Knox and Fort Leavenworth also yielded recommendations for training delivery in addition to the training performance requirements described earlier. As shown in Table 5, these mirror many of the advantages of simulation noted above as shown in Table 5. These training delivery requirements also centered around perceived needs for improved feedback and assessment, standardized and hands-on training, strategies for improving training efficiency and effectiveness (through cross-training, multiple iterations of training exercises, greater realism, and mission training prior to field deployment) and use of automated C3 devices integrated into training.

It is clear that simulation as a training strategy is receiving increasing recognition in the Army community. The problem facing users is to plan and structure simulation environments to maximize their capability to provide realistic and effective training exercises. The tools presented in this Research Product were designed to enhance this capability.

The Context for Tool Development

The tools presented in this Research Product were developed for use in the ARI-Knox research program on future battlefield conditions. This research was conducted using the Army's first DIS environment, the Close Combat Test Bed (CCTB), at Fort Knox. The following sections provide a brief overview of the focus of the ARI-Knox research and development program from which these tools emerged and the components of the DIS environment within which the program was implemented. This discussion is intended to provide the reader an understanding of the context in which the tools presented here were developed.

Table 5

Requirements for Training Delivery: Fort Knox and Fort Leavenworth Interviews

Objective data for training feedback
Quality assessment process through After Action Reviews (AARs)
Standardized training
Hands-on training
Cross-training
Multiple training iterations
Greater realism of classroom training
Mission-oriented training prior to field exercises
"Plug-in" C3 devices for integrated training

The ARI-Knox Research and Development Program. The Future Battlefield Conditions Team has been engaged in an ongoing program of research and development aimed at supporting the Army's requirements for future C3 systems. A major thrust of this work has focused on future Combat Vehicle Command and Control (CVCC) systems. As part of the CVCC program, ARI-Knox has been conducting simulation-based research on future C3 system configurations and the training requirements associated with these configurations.

The research program has included a series of simulation-based, soldier-in-the-loop evaluations of future tank systems and their associated training requirements. These efforts have proceeded in a bottom-up fashion from assessments of crew and platoon performance using a digitized position navigation (POSNAV) system (DuBois and Smith, 1989) and an automated Command and Control Display (CCD) for the tank commander (DuBois and Smith, 1991). A subsequent investigation examined the integration of the CCD and POSNAV with the Commander's Independent Thermal Viewer (CITV), a digitized target acquisition system for tank commanders (Quinkert, 1990). These efforts were followed by a series of investigations of company performance including: a company level evaluation of the operational effectiveness of companies equipped with CVCC systems including integrated POSNAV, CCD and CITV capabilities

(Leibrecht et al., 1992); an examination of the training requirements associated with the system (Atwood et al., 1991); and research on soldier-machine interface (SMI) issues associated with the design of CVCC user interfaces and controls (Ainslie, et al., 1991).

More recent evaluations are focusing on the extension of future C3 capabilities to the battalion level. These efforts include an evaluation of automated workstations to support a battalion Tactical Operations Center (TOC) (O'Brien et al., 1991) and an evaluation of battalion level performance currently in progress.

The tools described here were developed to support the FBC research program. They were designed to operated within a DIS environment. Key features of the DIS environment are described below.

The DIS Environment. The Army, along with the other military services, is currently engaged in the design of a DIS architecture. The DIS architecture is intended to provide a blueprint to guide the development of a general purpose simulation system which will meet the needs of a wide range of users, as shown in Figure 1 (from Beaver et al., 1992).

The DIS architecture is being structured to satisfy a large set of user objectives and implementation principles. However, the most pervasive and general requirement is for a man-in-the-loop simulation which simulates battlefield interaction between multiple warfighters at levels of fidelity that are sufficient to invoke realistic decision making behavior by the participants.

DIS is a direct descendent of simulation networking (SIMNET) technology. SIMNET was initiated in 1983 as a project on large-scale simulator networking by the Defense Advanced Research Projects Agency (DARPA). It was a proof-of-principle technology demonstration of interactive networking for real-time, person-in-the-loop battle engagement simulation and wargaming suitable for a broad range of applications (Alluisi, 1991).

The FBC team initiated its research and development program in the SIMNET facility established at Fort Knox. The facility includes standard SIMNET combined arms simulators routinely used for tactical training, particularly in the area of C3, housed at the Fort Knox Combined Arms Tactical Training Center (CATTC). An adjacent facility also includes developmental simulators designed to serve as reconfigurable weapon systems in which selected system characteristics can be modified to emulate conceptual weapon system configurations and their associated soldier-machine interfaces. These simulators are housed in the Fort Knox Close Combat Test Bed (CCTB) located adjacent to the CATTC.

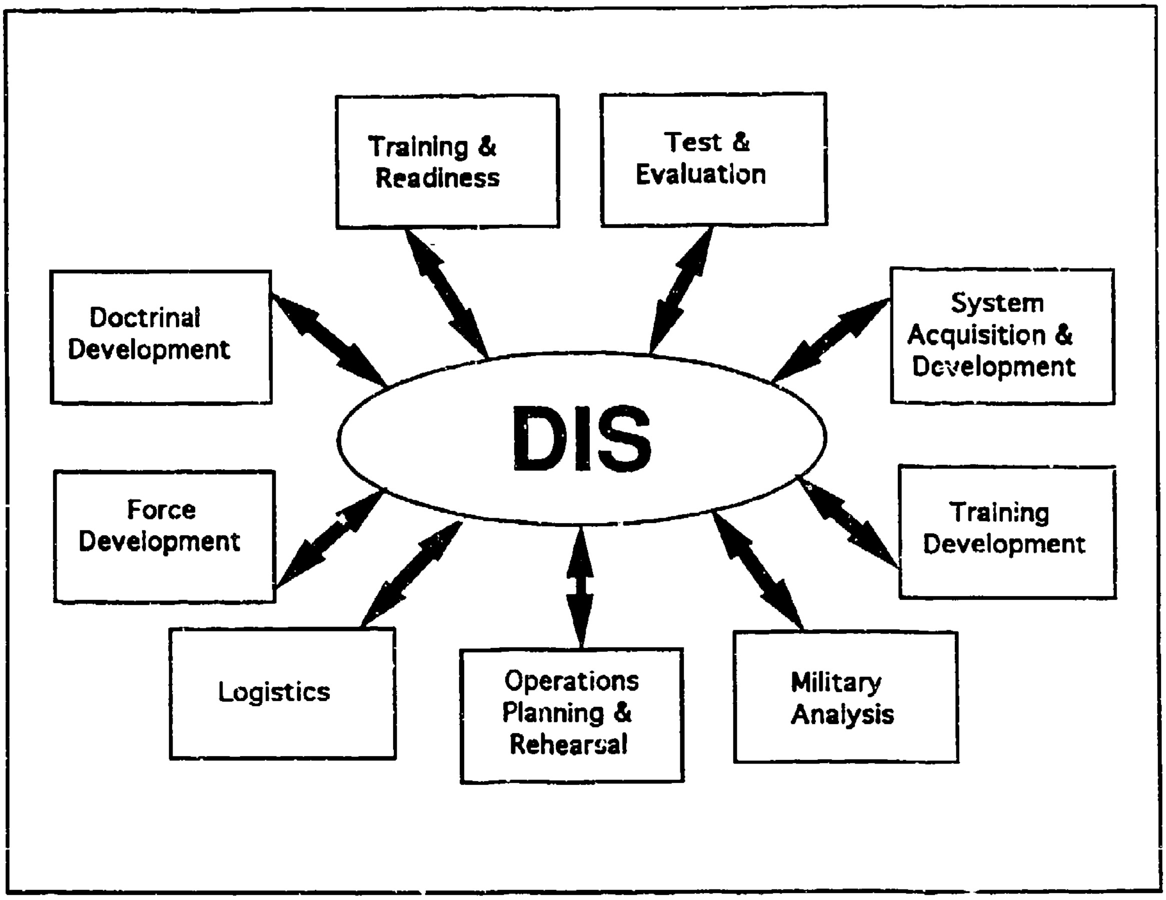


Figure 1. User needs to be met by Distributed Interactive Simulation (DIS) (from Beaver et al., 1992)

The FBC research program is being conducted in the Fort Knox CCTB. While many of the tools described in this research product have migrated to the CATTC, they were originally developed in the CCTB which offered the advantages of increased experimental control and reconfigurable simulators. In this case, the M1 tank simulators in the CCTB were configured with SIMNET-compatible C^3 prototypes and CVCC systems to support the ARI-Knox research program.

Figure 2 illustrates the SIMNET architecture which has supported the ARI program and the approximate physical location of components within the facility. These components provide the framework within which the tools described in this Research Product have been developed and implemented.

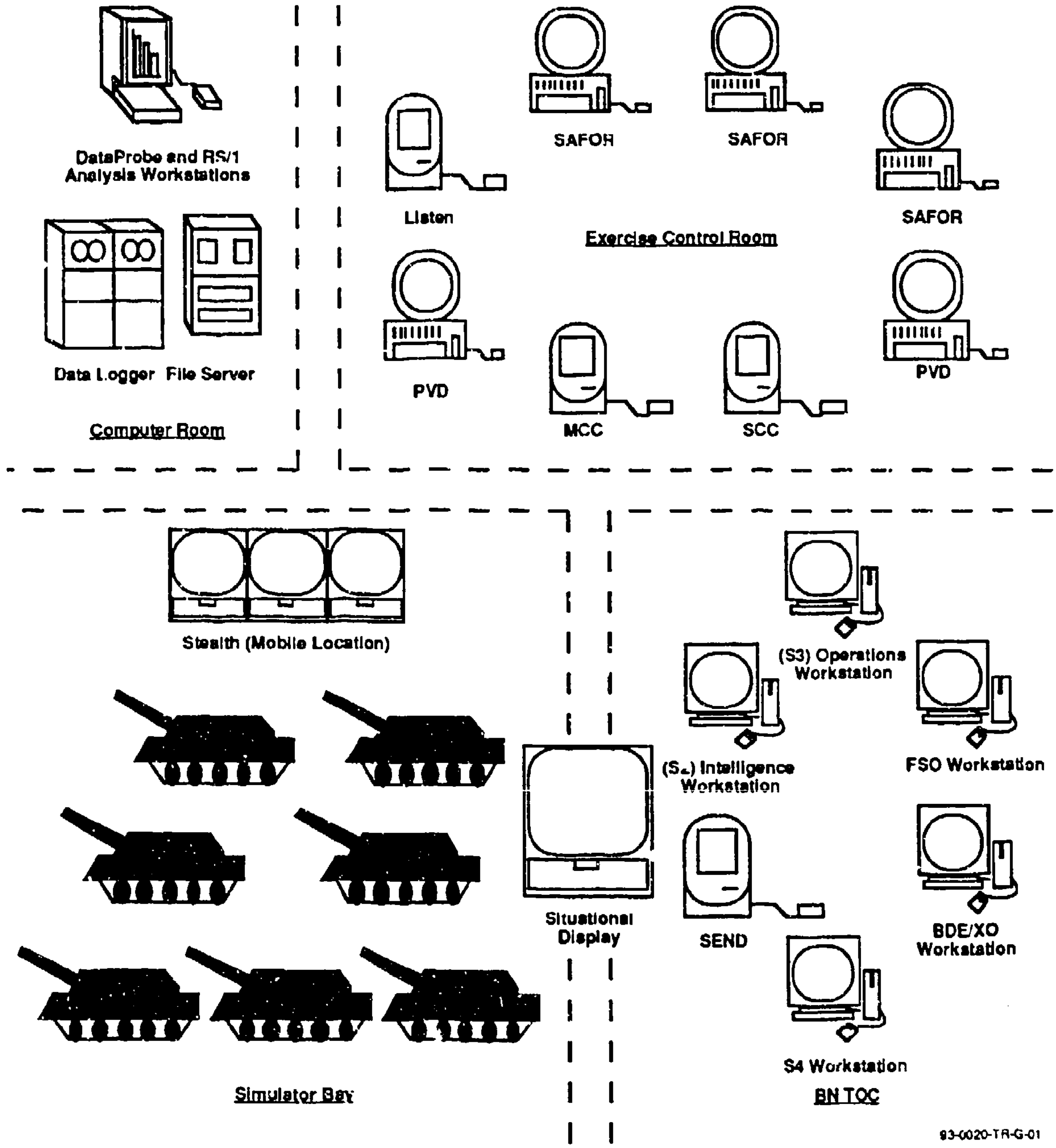


Figure 2. DIS architecture supporting ARI program

The architecture includes five major classes of components. The first class includes the simulators themselves shown in the simulator bay. These M1 simulators are built to be reconfigurable so that components can be utilized as required for a particular training or testing exercise. Thus, a particular component such as POSNAV or the CCD may be added to simulators to support a particular training or testing requirement. (The only exception to this modularity is the CITV which is integrated into the simulator

simulation software.) For the most recent ARI-Knox research effort, simulators were configured to operate with CVCC prototype systems (including an integrated POSNAV, CCD, CITV capability) or as standard baseline M1 simulators. The second class includes the automated Tactical Operations Center which includes workstations for battalion staff including an Intelligence Workstation, Operations Workstation, a Fire Support Workstation, a workstation which can be used as a Brigade or an Executive Officer Workstation, a Combat Service Support (S4) workstation, and a large screen Situation Display. (A SEND utility for transmitting automated messages is currently housed on the S4 workstation.)

A third major component identified in Figure 2 and located in the simulator bay is the Stealth. The Stealth is a phantom vehicle which can be used to traverse the battlefield without detection by battlefield participants. The Stealth has been used for a wide variety of purposes including terrain analysis, reconnaissance, and After Action Reviews (AARs).

A fourth class of components reside in or adjacent to the Exercise Control Room. They include:

1. A Management, Command and Control (MCC) system for controlling and monitoring manned simulators and implementing fire support;

2. A SIMNET Control Console (SCC) for initializing an exercise and setting battlefield parameters;

3. Semi-Automated (SAFOR) stations for creating and controlling unmanned vehicles and aircraft, both friendly (BLUFOR) and enemy (OPFOR);

4. A Plan View Display (PVD) for providing a "birds eye view" of the battlefield which can be used to monitor exercises and flag key events;

5. A LISTEN station to record digital messages; and

6. Radio nets for monitoring simulated SINCGARS radio traffic and communicating between control stations and manned simulators.

Finally, the computer room contains a set of components for use in data recording and analysis including: (a) a file server, (b) a Data Collection and Analysis System (DCA) for on-line recording of automated data and exercise playbacks (DataLogger), and (c) off-line reduction and analysis (Data Probe and RS/1 Analysis Workstations). (Data Logger, Data Probe, and RS/1 are registered trademarks of the BBN Software Products Corporation.) At present, all of these DCA components are only available at test-oriented DIS facilities such as the Mounted Warfare Testbed (MWTB) at Fort Knox. Currently, training-oriented DIS sites have

the file server and Data Logger systems to allow for recording of all automated data and subsequent exercise replay.

Taken together, this architecture provided the structure within which the enhancements described here were implemented. It provides the larger picture for interpreting how the specific tools described in subsequent sections can be integrated within a DIS environment.

More specifically, the remainder of this Research Product is organized into three main sections. These sections describe: (a) techniques for structuring simulation-based exercises; (b) strategies for eliciting and capturing C3 performance; and (c) approaches for demonstration, presentation, and analysis.

Techniques for Structuring Simulation-Based Exercises

Overview

This section presents three sets of tools for structuring simulation-based exercises. These tools allow the trainer to narrow the focus of an exercise to specific training tasks which can be executed in a shorter time period than an entire tactical scenario. They also provide a mechanism for reducing the personnel requirements for a particular exercise. Thus, taken together they offer tools for increasing training efficiency and improving the effectiveness of a training exercise.

More specifically, three sets of structuring tools are discussed below. They include: (a) tactical vignettes; (b) tethering and automated messaging; and (c) checkpointing.

Tactical Vignettes

Tactical vignettes were developed by ARI-Knox to structure exercise settings which are more constrained in focus than a full mission scenario and are capable of execution within a shorter time period. Two types of tactical vignettes have been developed. The first are "sandbox exercises" which are more open-ended and allow the unit commander to determine his course of action and to interact with his unit to make sure that his intent is understood. The sandbox exercise then focuses on execution of the commander's selected course of action. The second are "data collection exercises" which are more constrained and intended to focus on the execution of a specific course of action. The former type of tactical vignette provides a more general training tool, while the latter provides a more specific tool which can be used to address a more limited set of training objectives. While the two types of vignettes differ in scope, focus, and purpose, they share common features described below.

Capsule Description. Tactical vignettes are short exercises aimed at reinforcing crew skills, teamwork, reporting and navigation skills. They are centered around one significant event and generally last around 30 minutes. The significant event is designed to create a flow of information to the commander of the unit, to necessitate implementation of a decision by the commander, and to require execution by subordinate units. This information flow is supported through tactical radios as well as a prototype Command and Control Display (CCD) housed in the simulator. This approach allows soldiers to communicate by voice and digital messaging.

To conserve time and support standardized training, vehicle starting positions are established electronically through an initialization file so that vehicles are located consistent with the Operations Order (OPORD). This file may also specify unmanned vehicles which are "tethered" to manned vehicles to reduce personnel requirements (see following section for a description of tethering). Measures of performance (MOPs) related to each vignette are specified for automated data collection within the DIS environment. In some cases, radio nets are also monitored to collect performance data on reporting behavior. Battlefield events may also be monitored using the Plan View Display (PVD). The PVD allows an observer to watch movement, firing and other tactical events in real time as they occur during the exercise (see subsequent section on the PVD for a more detailed description). For any particular training exercise, vignettes are presented in a logical sequence within the context of the higher headquarter's OPORD.

Taken together, the ARI-Knox developed tactical vignettes provide a set of "mini-scenarios" which can be used to structure short, focused training exercises. They also provide a specific format for developers wishing to create additional tactical vignettes focused on specific training requirements. This format includes: (a) training objectives; (b) OPORD from higher headquarters to provide a context for a set of vignettes; (c) an OPORD for the unit commander to initiate the vignette; (d) predefined terrain and starting locations specified in an initialization file; (e) specifications of measures of performance (MOPs) for automated data collection; and (f) data collection formats for radio/PVD monitoring.

Applications. The tactical vignettes developed by ARI-Knox are essentially short, Situational Training Exercise (STX) like training events. As such, they support the emerging Combined Arms Training Strategy (CATS) presented in Coordinating Draft, TC 17-12-2) (Department of the Army, 1991a) which designates STXs for both active and reserve unit training. The specific data collection exercises designed by ARI-Knox draw their respective significant event from the Army Training and Evaluations Program (ARTEP) Mission Training Plan (MTP) for Tank and Mechanized Battalions, ARTEP 71-2-MTP (Department of the Army, 1988b). However, the tac-

tical vignette format could be easily adapted by training developers to accommodate training tasks for the Tank and Mechanized Infantry Company and Company Team, ARTEP 71-1-MTP (Department of the Army, 1988c) or the Tank Platoon, ARTEP 17-237-10-MTP (Department of the Army, 1988d).

The format and structure of the tactical vignettes address three of the nine training delivery requirements which emerged in our interviews with the Armor and Combined Arms training communities. More specifically, they support: (a) standardized training--since training vignettes are standardized for start-up terrain and location; (b) iterative training--since they are short and allow for the completion of multiple vignettes within a relatively constrained time frame; and (c) objective feedback--since MOPs and data collection formats are built into the tactical vignette format.

The tactical vignettes developed by ARI-Knox also address specific task areas identified as critical training requirements, particularly as seen by the Armor training community. For example, two critical C3 training requirements emerging from these interviews focused on managing incoming information appropriately and using voice and digital communications effectively. Since the tactical vignettes are specifically designed to define a significant event that triggers a flow of information between the unit commander and his subordinates and provide mechanisms for both voice and digital communication, they are well suited to these requirements. Table 6 illustrates the training objectives for one such tactical vignette. The second and fourth objectives listed are particularly germane to these training requirements.

Table 6

Training Objectives for One Tactical Vignette

EVENT A TRAINING OBJECTIVES
1. Practice tactical movement • 1st Platoon B - Internal Coordination • Coordination between manned and semi-automated forces Plts & Cos
2. Communicate using the revised net structure • Voice radio A and B nets (if both available) • Digital nets
3. Practice navigation as point platoon
4. Practice reporting procedures • Upward commo from wingman to Tactical Operations Center/ Battalion Commander • Downward commo from Tactical Operations Center/Battalion Commander to wingman
5. Become familiar with sequence and time constraints of a typical vignette

The current tactical vignettes are also well suited to two requirements in the maneuver area identified as critical in our interviews with the Armor community. These include operating effectively as crews and navigating on varied terrain under varied conditions. Objectives 1 and 3 in Table 6 are directly relevant to these requirements.

Training objectives taken from a second tactical vignette are shown in Table 7. They also illustrate the applicability of this training format for communication and reporting (objectives 1 and 3) and maneuver (objective 2).

Table 7

Training Objectives for a Second Tactical Vignette

EVENT B TRAINING OBJECTIVES
1. Reinforce new manning and net structures
2. Practice tactical movement with vignette structure **• Emphasize actions on contact**
3. Reinforce reporting procedures **• Generate & process CONTACT & SPOT reports** **• Process Fragmentary Orders (FRAGOs) "under fire"**

In summary, the tactical vignette format is a useful strategy for delivering STXs in a simulation-based environment. The specific vignettes developed by ARI-Knox provide "mini-scenarios" which can be used to train selected C3 and maneuver tasks, particularly crew skills, teamwork, reporting and navigation skills. The tactical vignette format also provides a model for training developers wishing to extend the existing set to other training requirements.

Resources. Two primary documents are available to potential users or developers of tactical vignettes for use in a simulation environment. They include:

O'Brien, L.H., Leibrecht, B.C., Ainslie, F.H., Williams, G.S., and Smart, D.L. (1991). Research plan for the combat vehicle command and control battalion-level formative evaluation. Volume 3 (ARI Technical Report). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Leibrecht, B.C., Kerins, J.W., Ainslie, F.A., Sawyer, A.S., Childs, J.M. & Doherty, W.J. (1992). Combat vehicle command and control systems: I. Simulation-based company level evaluation (ARI Technical Report). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Tethering and Automated Messaging

Tethering and automated messaging are two ARI-Knox developed strategies for augmenting the capabilities of BLUFOR training in the DIS environment. Tethering allows unmanned vehicles to be configured as subordinate units and to operate as members of the BLUFOR unit using the SAFOR capability. Automated messaging provides a technique for simulating message traffic from the leader of the unit of unmanned vehicles. This technique relies on the use of a prototype automated C3 device for receipt of automated messages in manned simulators.

While the following discussion focuses on the use of tethering and automated messaging to enhance the capabilities of BLUFOR units, the reader should note that tethering is also possible when the SAFOR capability is used to represent the OPFOR. In this case, an OPFOR commander may operate on the digital battlefield through a simulator with unmanned vehicles configured as subordinate units using tethering. At this time, the automated messaging capability described below does not exist for the OPFOR; however, this capability could be provided relatively easily if required.

Capsule Description. Tethering is a strategy for augmenting friendly (BLUFOR) units with subordinate units comprised of unmanned vehicles using the Semi-Automated Force (SAFOR) capability. There are two main modes for structuring tethering. In the first mode, the Command mode, unmanned vehicles are configured as a unit (such as a platoon) and are "tethered" to the manned simulator of their next higher commander (in this case, the company commander's (CO's) vehicle which is a manned simulator). The SAFOR unit then moves up and forms on the commander's simulator and responds to his orders through the workstation operator. The SAFOR unit will move in the formation and at the speed directed by the company commander through the workstation operator (who acts as the subordinate platoon leader).

The second mode is the Follow mode. In this case, units are configured without the unit command element (for example, a platoon is established without its platoon leader). The three tanks are then tethered to the platoon leader and simply conform to his movement in a follow mode. Their appearance on the simulated battlefield is identical to a fully manned platoon.

In this way, subordinate units comprised of unmanned vehicles can be "tethered" to manned vehicles in a variety of configurations depending on training requirements and personnel availability. While SAFOR has historically been used to portray Opposing Force vehicles (OPFOR), this ARI-Knox designed strategy provides a substantial increase in the training capabilities of the DIS environment. It allows for flexibility in manning training exercises and provides an approach for structuring exercises specified in the emerging Combined Arms Training Strategy (CATS) as

described in Coordinating Draft, TC 17-12-7 (Department of the Army, 1991a). These events include: (a) Tactical Exercises Without Troops (TEWTs), (b) Command Post Exercises (CPXs), and (c) STXs. Use of tethering in structuring these types of training events minimizes required personnel resources, increases training time in specific positions (such as company commander or platoon leader) since multiple iterations of an exercise can be run in the time it would take for one comparable field exercise, and retains realism without the addition of personnel resources.

More specifically, tethered units of unmanned BLUFOR vehicles are initialized, monitored, and controlled through the SAFOR BLUFOR station. (Four such workstations exist at the DIS facility at Fort Knox; however, the number may vary at other DIS facilities.) Initial files are created for each training exercise and scenario which allow units comprised of unmanned BLUFOR vehicles to be named, configured within the unit chain of command and called up in their correct starting locations. The initialization process also allows the SAFOR operator to specify the tethering mode in which the unit will operate (Command or Follow) as previously described. In addition, the markmanship level of the unit can be designated by the SAFOR operator as "Master," "Competent" or "Novice." A "Master" setting multiples the probability of hit by 1.00. A "Competent" setting multiplies the probability of hit by 0.75. A "Novice" setting multiplies the probability of hit by 0.50. The BLUFOR operator may also designate the fire status of the unit vehicles. "Hold Fire" status indicates that vehicles will not be able to shoot. "Fire at will" indicates that vehicles will be able to shoot when a detected enemy is in range. These files are created and saved before a training exercise, then loaded prior to the start of the exercise.

Once the exercise begins, the BLUFOR SAFOR operator monitors battlefield events using the workstation. The SAFOR operator may view the battlefield from one of two perspectives. The first viewing mode is the Commander's View. This perspective allows the operator to view the state of the battlefield as seen from the unit commander's simulator. The second viewing mode is the Omnipotent View. This perspective allows the operator to view the entire battlefield without regard to the perspective of any particular simulator. In both viewing modes, the workstation provides a top-down color map display showing the current state of the battlefield. The operator can zoom or pan to any point on the map display and can choose to display map features (such as contour lines, UTM grids, roads, water, trees and bridges) to facilitate the monitoring process. When the operator wishes to control a particular tethered unit, he or she may enter performance parameters such as movement, speed, and engagement activity using the keyboard.

The realistic portrayal of tethered units can be enhanced through a second ARI-Knox developed strategy, <u>automated messaging</u>. This approach allows the SAFOR to send battlefield messages from

the leader of the unmanned unit in real time. This capability includes multi-echelon relay of messages as well as built-in realistic time delays for message traffic. It allows training of higher echelon leaders using fewer personnel resources as well as enhancing the realism of unmanned "tethered" units by providing a communications capability. This capability also supports training of information acquisition, processing, and dissemination tasks by providing a mechanism to simulate message traffic and increase message load without increasing person el.

More specifically, the SAFOR workstation can be used to set automated reporting requirements for tethered units. Several types of reports can be sent out to simulate message traffic from an unmanned unit leader including: contact, spot, shell, situation and ammo status reports. These messages are received by manned simulators as digital messages displayed on a prototype C3 device called the Command and Control Display (CCD). The CCD allows commanders of manned vehicles to review, process, and disseminate messages. Messages from unmanned simulators cannot be distinguished from those sent by manned simulators. The SAFOR messaging capability provides automatic built-in time delays for training realism and relays across echelons as appropriate.

Applications. Tethering and automated messaging provide tools for structuring realistic simulation-based exercises while minimizing the requirements for BLUFOR personnel. From a training delivery perspective, these ARI-Knox developed tools allow structuring of simulation-based exercises which meet several of the nine requirements identified by the Armor and Combined Arms training communities. Taken from Table 5 presented earlier, they include requirements for: (a) standardized training--since the actions of unmanned "tethered" units can be specified in the initialization files and controlled by the SAFOR operator; (b) hands-on training--since individuals have greater access to simulation-based training because the personnel resources for any particular exercise are reduced; (c) cross-training--since individuals within manned vehicles may trade positions or be reinitialized to different positions with additional units participating via tethering; (d) multiple training iterations--since the personnel requirements for any particular exercise are reduced using tethering and it is more feasible to conduct multiple iterations of training exercises with participating personnel; and (e) greater training realism--since larger, more complex exercises can be structured with fewer personnel than would normally be possible.

Tethering has been used as a tool for structuring a variety of training exercises focused on a range of training objectives. It provides a strategy for delivering more focused training on the fundamentals of C3 (noted as critical by the Armor and Combined Arms training communities in our interviews) but keeping personnel requirements manageable. While many applications of tethering can be imagined, three types of applications are of particular value

and potential interest to the Army training community. These include the use of a horizontal slice, a vertical slice and focused messaging, and are described below.

The horizontal slice is illustrated in Figure 3. This figure shows a horizontal slice at the company level. In this case, the Company Commander (CO), Executive Officer (XO), and the three platoon leaders participate in the exercise in manned simulators. The remaining three vehicles in each platoon are tethered to their respective platoon leaders as unmanned simulators. The reduction in personnel requirements structured in this manner are substantial. If all the vehicles represented in Figure 3 were manned, fourteen four-man crews (or fourteen three-man crews if an automatic loading capability exists in the simulator) would be required for a total of 56 (or 42 with the automatic loader) soldiers. In contrast, with nine tethered vehicles, the personnel requirements are reduced to five four-man crews (or five three-man crews with an automatic loader) for a total of 20 (or 15 with the automatic loader) soldiers. This represents a 64% reduction in personnel requirements for an exercise structured in this way.

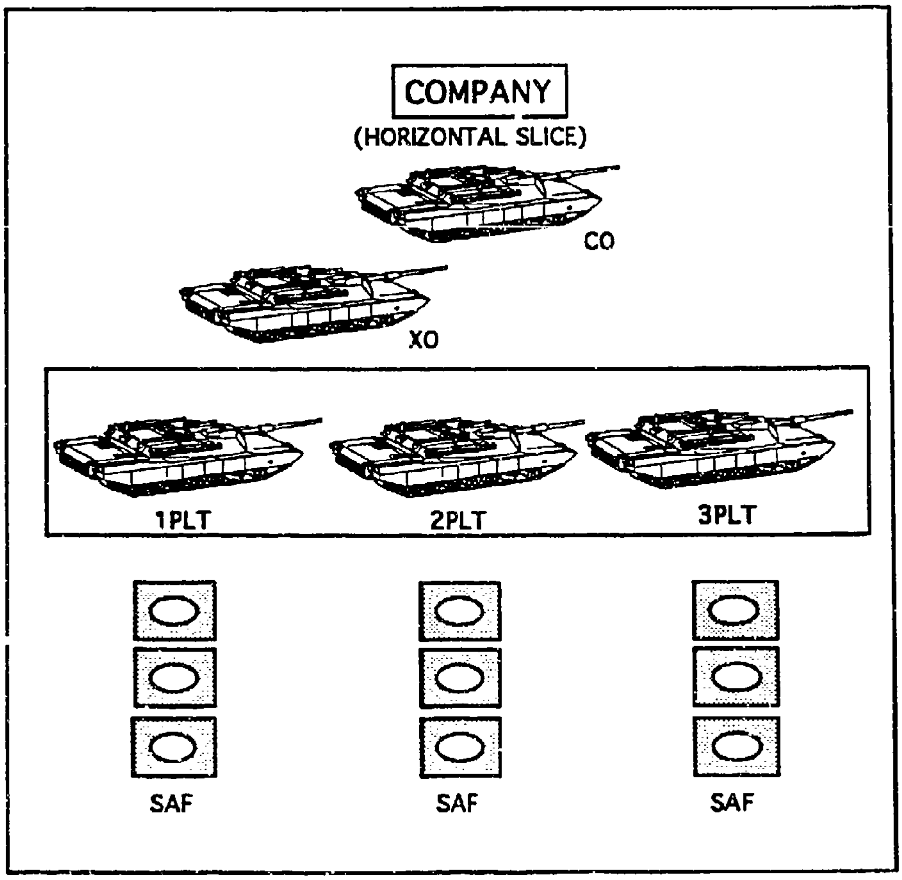


Figure 3. A company-level horizontal slice using tethering

The horizontal slice is particularly useful for training focused on a particular command level. Such training requirements often occur in institutional training where courses are focused on preparation for particular positions, such as Armor Officer Advanced Course (AOAC) which trains potential Company Commanders and the Armor Officer Basic Course (AOBC) which aims at preparing future platoon leaders.

As an example, the horizontal slice is well suited to structuring simulation-based training exercises for institutional courses such as AOAC and AOBC because it allows students greater opportunity to participate in the position for which they are being trained. The configuration shown in Figure 3 is well matched to preparing AOBC students for mounted tactical training (currently representing 160 hours of instruction in the AOBC Program of Instruction or POI). A horizontal slice moved up an echelon to include manned simulators for the Battalion Commander (Bn Co), XO, and COs supported by tethered platoons could serve a comparable role for AOAC students. The current AOAC POI includes tactical training for offensive and defensive missions (including deliberate attack, movement to contact, defense in sector, defend a battle position, and delay) which are well suited to simulation-based exercises using tethering.

A vertical slice may also be configured using tethering which provides manned simulators at each level of the command chain with unit augmentation at each level by tethered, unmanned simulators. For example, Figure 4 illustrates a battalion level vertical slice. In this case, manned simulators are used at Battalion for the Bn Co and his Operations Officer (Bn S3). At the company level, manned simulators are used for one CO and his XO with the remaining COs and XOs supplied as tethered vehicles. Similarly at the platoon level, one of the manned CO's platoons (including the platoon leader, platoon sergeant and two wingmen) participate in manned simulators. Other platoons associated with the manned CO's vehicle as well as the other unmanned CO's vehicles are represented in the exercise using tethering.

Again, the savings in personnel requirements are considerable. As shown in Figure 4, eight manned simulators are required for one battalion level vertical slice. Using tethering, the remaining 26 vehicles (three COs, three XOs, the remaining eight platoon vehicles tethered to the manned CO and twelve platoon vehicles tethered to their respective unmanned CO vehicle) can be represented without additional personnel requirements. This strategy brings the personnel requirements down from 232 (four man crew) or 174 (three man crew) soldiers if all simulators were manned to 32 (four man crew) or 24 (three man crew) soldiers. using tethering. In this vertical slice example, the savings in personnel required is over 85%. It can be readily seen that the conduct of the simulation-based exercises themselves, especially on an iterative basis, are much more logistically feasible using tethering as a structuring tool for the exercise.

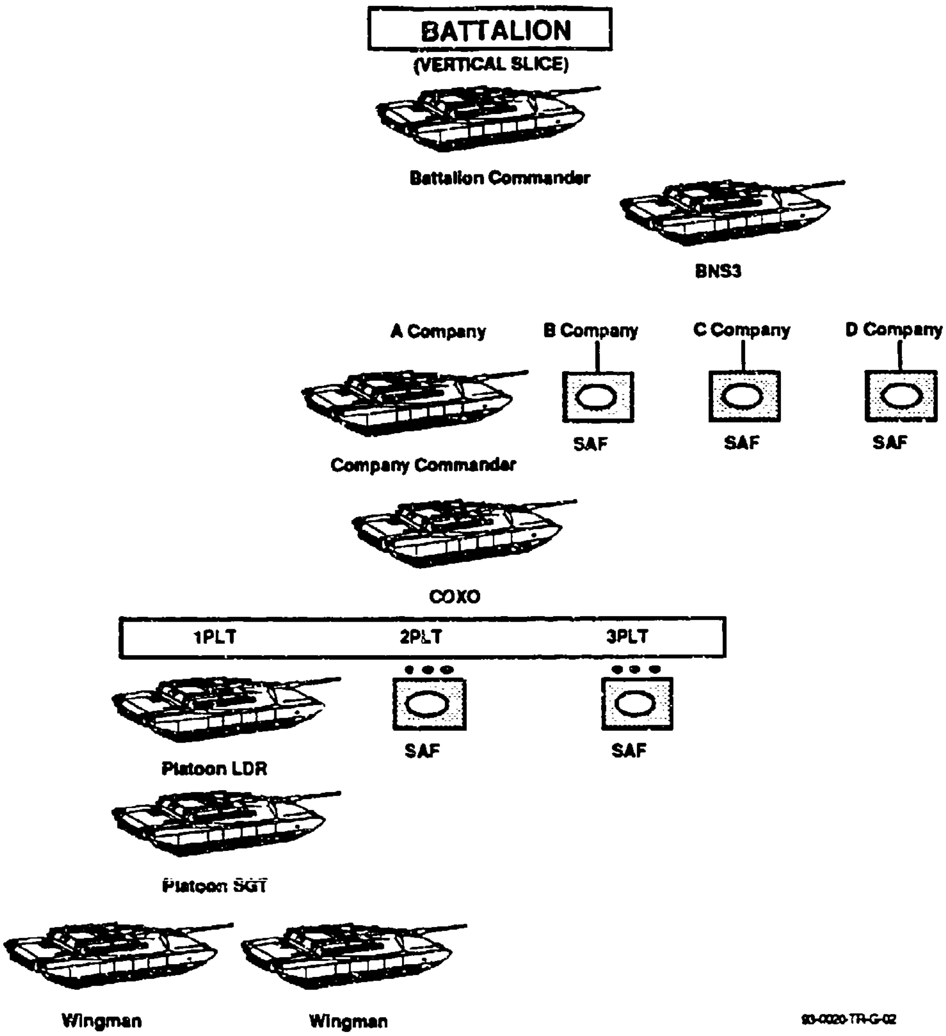


Figure 4. A battalion-level vertical slice

A vertical slice structure is particularly applicable to training objectives focusing on the C3 interactions up and down the chain of command. This focus is, of course, of particular importance in unit training where leaders must learn to work together effectively. The emerging battle-focused Combined Arms Training Strategy (CATS) currently under coordination by the Armor community as Coordinating Draft, TC 17-12-7) (Department of the Army, 1991a) calls for a number of training events that are well suited to a vertical slice training strategy. These include Tactical Exercises without Troops (TEWTs) and Command Post Exercises (CPXs) in particular.

Finally, focused messaging is a third application which is emerging in importance. Focused messaging uses the automatic messaging capability of the SAFOR to provide real time generation of battlefield messages from the leaders of tethered units. These

messages can be focused in content and format depending on training objectives and can be relayed across echelons with appropriate time delays built in. (Automated messaging can be further enhanced with the use of the SEND utility described in a subsequent section of this Research Product.)

There are at least two important training applications for focused messaging. First, messages can be formulated to serve as prompts for leader action. This approach provides leaders with a structured opportunity to deal with specific types of C3 problems within a tactical situation. For example, the Mission Training Plan for the Tank and Mechanized Infantry Company and Company Team, ARTEP 71-1-MTP, (Department of the Army, 1988c) identifies the following subtask associated with the sustainment of combat operations: "The commander, XO, and 1SG analyze the mission with input from key NCOs and leaders to determine anticipated ammunition, supply and service requirements" (Subtask 12, p. 5-198). Focused messaging allows messages to be formulated prior to the exercise which will give company leaders the opportunity to deal with specific combat service support (CSS) planning of this type.

Secondly, the automated messaging provides a strategy for training information management skills. As noted in the interviews described in the introductory section, there is a growing recognition within the Army community of the importance of training leaders to process and manage information effectively. These skills are becoming increasingly important as the Army moves toward the fielding of automated C3 devices with digital messaging capabilities (see, for example, Henderson, 1992).

Figure 5 provides a graphic representation of the automated messaging capability. Essentially, this capability allows for the transmission of messages from leaders of unmanned units using the SAFOR to manned vehicles. It should be noted that automated messages will always originate from the commander of the unit represented by the SAFOR even though there are multiple unmanned vehicles comprising his unit. So, as shown in Figure 5, all automated messages originate for the platoon leader (A21) and are transmitted to the CO. (Automated messages cannot originate from other vehicles in the platoon; i.e., A22, A23, A24.)

Automated messaging allows a greater number and more types of messages can be sent than might otherwise be possible. These messages are received by the manned vehicle in digital form using a prototype C3 device housed in the simulator. The leader in the manned vehicle is then faced with the opportunity to acquire, process and disseminate this information efficiently and effectively.

Army training doctrine is currently evolving and can be expected to more explicitly articulate training tasks related to information acquisition, processing and dissemination (i.e., information management) in the future. However, both institutional and unit training currently focus on selected aspects of

information management which lend themselves well to training using automatic messaging. For example, from an institutional training perspective, the AOBC POI currently includes sections on combat communication techniques and battlefield information reporting. An example from a unit training perspective is the Mission Training Plan for the Tank and Mechanized Infantry Battalion Task Force, ARTEP 71-2-MTP (Department of the Army, 1988b) which includes the task, "Maintain Communications" as an element of Battalion Command and Control. While the specific subtasks associated with this task focus primarily on radio communications, digital communications represents an alternative communication means.

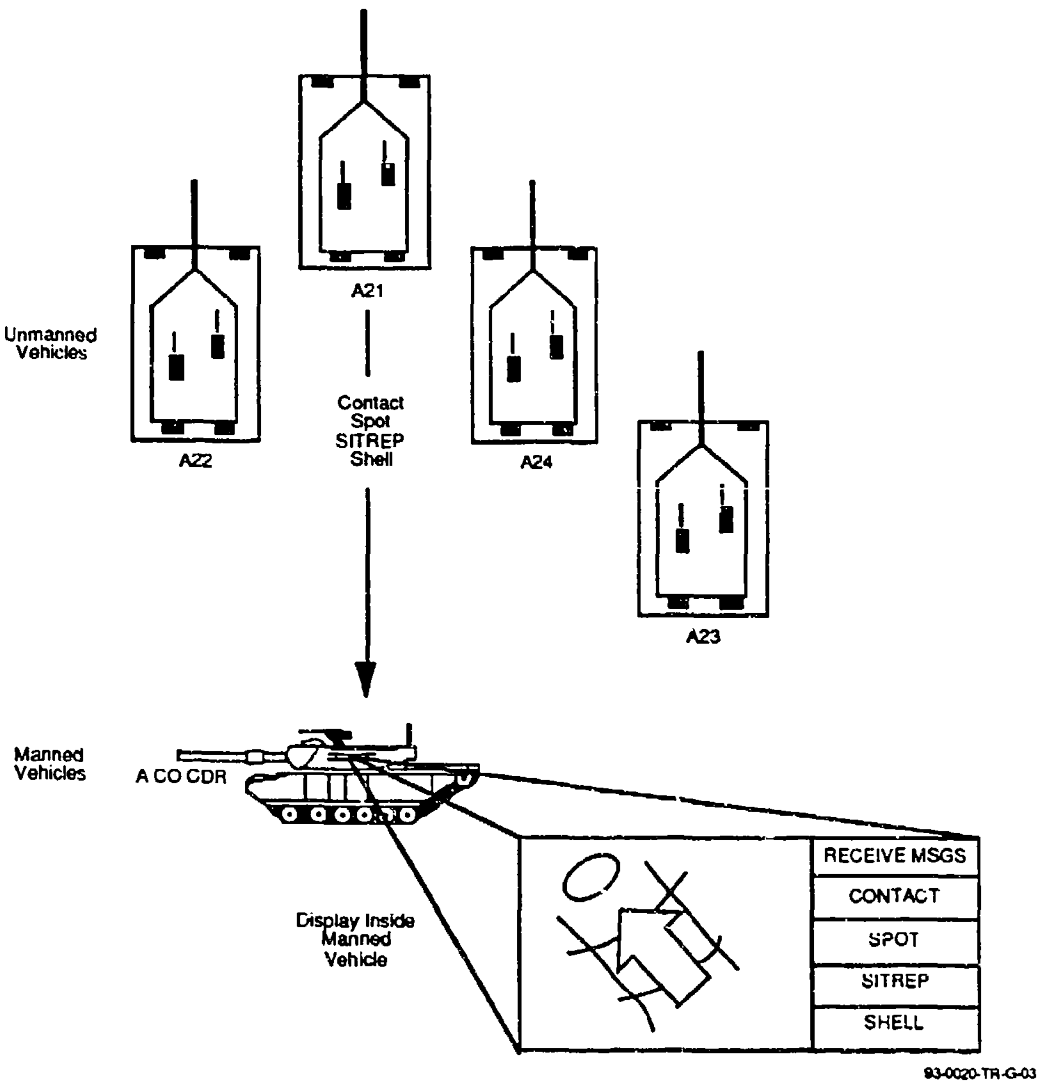


Figure 5. Automated messaging to support training of information management skills

In summary, tethering and automated messaging are powerful tools for structuring training exercises that take full advantage of the SAFOR capability within a simulation environment. They provide a flexible strategy for reducing personnel requirements, focusing the training experience on key positions and supplementing message traffic to support specific training objectives. (Readers should note that the current SAFOR capability within the DIS environment is scheduled to be updated with a modular semi-automated forces (MODSAF) capability during the summer of 1993. Documentation on MODSAF is expected to be available in DIS facilities at that time.

Resources. A number of documents on the use of the SAFOR workstation are available for the prospective DIS user. Chief among these is the User's Guide for the workstation:

Saffi, M.R. (1991). SIMNET semi-automated forces: The combined arms workstation user's guide (Report No. 7025). Cambridge, MA: BBN Systems and Technologies Corporation.

Also available are updated release notes published periodically and typically appended to the User's Guide available in the DIS facility. Unpublished materials include a set of briefing charts entitled "SAF Troubleshooting Guidelines" and SAFOR Operator Instructions.

Checkpointing

Checkpointing is a software utility that is housed on the Battalion Tactical Operations Center (Bn TOC) workstations. Checkpointing allows the current state of an exercise to be saved so that it can be retrieved at a later time.

Capsule Description. Checkpointing essentially allows an exercise to be "frozen" and saved for future use. When the checkpointing utility is invoked, the current state of all workstations and simulators configured on the network with which the user's workstation can communicate is saved. For example, if a network were configured with three TOC workstations (the Intelligence, Operations and XO workstations) communicating with six M1 tank simulators, the checkpointing utility would send messages to all three workstations and all six simulators to save their current states. For the workstations, the current state includes: location of map center, map scale, Bn TOC location, all overlays belonging to a particular workstation, the set of overlays visible at the time of checkpointing, all messages in the system and their distribution (that is, to folders, journal and workbook) and all formats belonging to a particular workstation. For the simulators, the current state includes simulator location, and fuel and ammo status as well as comparable elements housed within the Command and Control Display (CCD).

The checkpointing utility has four main functions. The first, Checkpoint, allows the user to save the current state of an exercise. This function requires the user to select the Checkpoint option and to enter a name for the checkpoint file to be created. The software then creates the checkpoint file as named which includes the current state of all communicating simulators and workstations on the network and records the date and time that the exercise state was saved.

The second checkpointing function, Delete, allows the user to delete checkpoint files that are no longer needed. Since these files require a considerable amount of disk space, it is desirable to delete files after the requirement for their use has passed. Using the Delete function is a simple matter of selecting the function and the file name and confirming the selection. The software then deletes the selected checkpoint file.

The third checkpointing function, Restart, allows the user to restart an exercise at the point where it was previously "frozen". The user simply selects the Restart function and the name of a previously saved checkpoint file and confirms the selection. These actions restore the exercise to its checkpointed state and changes screens at workstations and in the simulators to reflect the status of the restarted exercise.

The fourth checkpointing function, Shutdown, allows the user to conclude an exercise. This action requires the user to select the function and to confirm the selection. At this point, all workstations and simulators on the network are shut down.

Applications. The checkpointing utility offers numerous advantages from the perspective of training in a DIS environment. From a training delivery view, Checkpointing allows the trainer to "freeze" scenarios at key points which are well suited for demonstration of an important teaching point. Furthermore, since scenarios can be saved at any point within the engagement, training exercises do not necessarily need to start at the beginning of a scenario. Thus, exercises can be shorter in duration without loss of training value and training time can be used more efficiently. These efficiencies allow for the delivery of a greater frequency of training exercises and more iterations of exercises focused on specific tasks than would otherwise be possible. The latter requirements for training delivery were perceived as particularly important in our interviews with the Army training community.

There are at least three specific training applications for which the checkpointing utility is well suited. These applications, which emerged as important training requirements in our interviews with members of the training community at Fort Knox and Fort Leavenworth, can be used for both institutional and unit training. They include using checkpointing to build scenarios for training: information management skills, fundamental C3 skills, and operation as an integrated battalion staff.

With the advent of automated digital communications, information management skills are becoming increasingly recognized within the Army community as important for success on the battlefield. While current Programs of Instruction (POIs) within the institutional training community and current Mission Training Plans (MTPs) intended for unit training do not explicitly call them out, it is reasonable to expect that these skills will be included as automated command and control devices are fielded.

ARI-Knox has recently developed an Information Management Exercise (IMEX) using the checkpointing utility in a DIS environment. The IMEX is intended to provide individual training to soldiers on the receipt, processing and dissemination of information using automated digital communications. The exercise uses a network of four double-screened workstations to provide a training exercise which can accommodate four participants at a time. One of the monitors at each workstation displays an automated CCD which is used by the student to manage tactical information. The other monitor is used for presenting instructional materials to students including training objectives, tactical information such as OPORD extracts, control messages and feedback on performance (see Winsch, et al., in preparation, for a complete description of the IMEX).

The checkpointing utility was used to create starting states for the training vignettes used in the IMEX. For each vignette, overlays for the tactical map and "old" (i.e., previously received) messages were sent to a workstation with CCD software to establish the starting state of the display for each vignette. Once the training developers were satisfied that the display represented an appropriate starting point for the vignette, the file was saved using the Checkpoint function. Four checkpoint files were created in this manner, one for each vignette. During an actual exercise, the checkpoint file for a vignette is simply activated at the appropriate time using the Restart function. (The messages for student actions are transmitted to the Workstation using another ARI-Knox developed utility, SEND. This utility is described in the following section of this research product.) In this way, the checkpointing utility provides a valuable tool for structuring short, focused exercises (such as the IMEX vignettes) for use in DIS-based exercises.

A second rich application area for checkpointing is in the training of fundamental C3 skills. The importance of these skills was consistently underscored in our interviews with the Army training community. The prevalent view was that since the important C3 skills have been well articulated in training doctrine, the training requirement centers on developing more effective training approaches.

Checkpointing can be used to create a library of exercise files related to training specific C3 skills. This library could contain files aimed at the same training objective or task to

allow for multiple iterations and practice until the standard is achieved. These files could also be sequenced to require performance under increasingly difficult conditions. It would also be possible to sequence these sets of checkpointed files so that they provide a basis for conducting a series of exercises on C3 skills.

Specific examples of C3 skills for which training exercises could be structured in this way can be found in the MTPs for the: tank platoon, ARTEP 17-237-10-MTP (Department of the Army, 1988d); the tank and mechanized infantry company and company team, ARTEP 71-1-MTP, (Department of the Army, 1988c); and the tank and mechanized infantry battalion task force, ARTEP 71-2-MTP (Department of the Army, 1988b). Table 8 highlights illustrative C3 tasks in the planning phases from the company and company team MTP which could be treated in this way. While these tasks represent a planning cycle that can be trained from beginning to end, it is noteworthy that this is a multi-step process which is time consuming to undertake and train. Using the checkpointing utility, it would be possible to build a scenario which focuses on one task within the cycle, such as developing courses of action. In this case, the company team commander would be provided with the tactical situation and related information generated to that point. The training exercise would focus specifically on the task of generating courses of action and checkpointed scenarios could be structured to allow him the opportunity to perform this task under different conditions and with varying amounts and nature of information available.

The key point here is that the DIS environment coupled with the checkpointing utility allows trainers to carefully structure short, focused exercises aimed at specific C3 training objectives. Instead of having to start at the beginning of a scenario, the tactical situation can be "fast forwarded" to a predetermined point which has been saved for later restart using the utility. This approach offers greater efficiency in the form of training time savings and greater effectiveness in the form of increased focus on specific training tasks and objectives.

Finally, a third application area well suited to the use of checkpointing is training operation as an integrated battalion staff. This area was emphasized as an area of critical training importance, especially in our interviews with members of the training community from the Combined Arms Command at Fort Leavenworth.

Operating as an integrated battalion staff is a difficult and complex training task. Staff officers must not only know how to perform the tasks associated with their own positions, they must learn to work together effectively. Working together means not only understanding each other's working style and coordinating efforts in an effective manner, but also having sufficient understanding of the tasks performed by other staff officers so that appropriate information can be provided at the appropriate time.

Table 8

Fundamental C3 Task at Company-Level Appropriate for Checkpointed Training Scenarios (From ARTEP 71-1-MTP; note that subtasks are not shown)

- **The company team commander:**

  1. reviews the OPORD
  2. performs a mission analysis
  3. issues a warning order
  4. develops courses of action
  5. makes a tentative plan

- **The company team:**

  6. initiates movement as required for quartering party, selected units, or entire team
  7. conducts reconaissance

- **The company commander:**

  8. completes the plan based on METT-T, intelligence from the reconnaissance and other available resources

  9. issues his orders to his subordinate leaders

Checkpointing allows battalion staff officers to work together on one set of tasks at a time rather than requiring them to perform all tasks over the course of an entire scenario. As in the company example above, this focus allows more efficient use of training time and a more constrained set of training tasks on which to focus. Examples of tasks taken from the Mission Training Plan for the Tank and Mechanized Infantry Battalion Task Force, ARTEP 71-2-MTP (Department of the Army, 1988b), include: (a) staff develops an OPORD from the commander's guidance; (b) commander and staff coordinate and refine the plan; and (c) Task Force leaders command and control the execution. Of course, training should eventually include a full-up scenario from beginning to end so that battalion staffs have the opportunity to perform the full cycle of required tasks. However, building up from smaller sets corresponds to the Army's crawl-walk-run philosophy of training which calls for gradual increments in difficulty and complexity.

Furthermore, shorter checkpointed scenarios also offer opportunities for cross-training. Individuals can switch staff positions and checkpointed scenarios can be repeated to provide them an opportunity to perform in another role; thereby gaining an understanding of the skill requirements across various staff positions. The need for such cross-training also emerged in our

interviews at Fort Leavenworth as an area requiring attention in Army training.

A final aspect of battalion staff integration which lends itself well to the use of checkpointed scenarios is training for shift changes and movement of battalion command posts (CPs). Battalion staff members typically work a 12 hour shift in a combat situation. When they resume their duties after a shift change, they must quickly become updated and prepared to deal with conditions which have changed in their absence. Checkpointed scenarios provide a mechanism for training smooth shift hand-offs by structuring opportunities for battalion staff to perform under one set of conditions and timeframe and then to undertake their duties in a second scenario checkpointed to reflect changes which have occurred in their absence. A similar approach could be taken with the movement of CPs, since a "CP jump" requires battalion staff to alter their perspective to the new location and quickly update their picture based on events that may have transpired during their physical relocation.

In summary, checkpointing is a very useful tool for structuring training exercises in a DIS environment. It allows scenarios to be "frozen" at a particular point for future restarting. Thus, shorter, more focused training situations can be established which allow units and soldiers to focus in on a restricted set of training tasks. This focus avoids the dilution which sometimes occurs when many training tasks are addressed in a single exercise and allows for efficient use of training time since it is not necessary to start at the beginning of a scenario or to experience all of the events which lead up to a given point on the battlefield.

<u>Resources.</u> Users interested in the checkpointing utility should consult the Battalion Tactical Operations Center (Bn TOC) Workstation User's Guide. This guide contains a section with specific instructions for using the four functions of the checkpointing utility (see pp. 3-6 - 3-8).

Bolt, Beranek & Newman, Inc. (1991a). <u>SIMNET CVCC Battalion Tactical Operations Center (Bn TOC) Workstation User Manual</u> (Release 1.5, Report No. 7629). Cambridge, MA: BBN Systems and Technologies Corporation.

Strategies for Eliciting and Capturing C3 Performance

<u>Overview</u>

This section describes four tools for eliciting and capturing Command, Control, and Communication (C3) performance. The first strategy provides the capability for trainers to use prototype devices within the DIS environment to prompt C3 behaviors of

leaders and to record their performance. The second two strategies provide supporting utilities which minimize personnel requirements for C3 exercises and produce a written record of soldier actions. Finally, the fourth strategy provides a mechanism for examining the effectiveness of C3 performance by comparing the correspondence between the maneuver of blue force units and the location of their designated control measures. Thus, they serve as important tools for planning and delivering training of C3 skills and for providing objective feedback on performance.

The four strategies are presented below. They include (a) instrumented devices; (b) the SEND utility; (c) the LISTEN utility; and (d) a control measure performance measurement system.

Instrumented Devices

The use of instrumented devices is a strategy developed to elicit C3 behavior in a realistic manner and to capture measures of performance for use in training feedback. This approach capitalizes on the capabilities of the DIS environment by introducing a C3 device into reconfigurable M1 simulators and building data hooks into the device software so that the performance of soldiers on these measures can be captured using the data collection and analysis system.

Capsule Description. Use of instrumented devices for conducting C3 training in a simulator-based exercise requires configuration and integration of four major capabilities within the DIS environment. These capabilities are: (a) reconfiguration of the vehicle simulators; (b) development of the instrumented device; (c) specification of data hooks for desired automated measures of performance; and (d) use of the data collection and analysis system.

An important capability in the DIS environment is the nature of the simulators themselves, more specifically, their reconfigurability. Simulators are built to facilitate changes in the physical configuration of weapons, sensors, and command and control systems. Crew compartments are made of modular components that can be rearranged into different configurations. Maximum use is made of "soft" programmable switches activated by a touch screen to make the layout of new controls a computer programming task rather than requiring the hard wiring of actual switches. Standard computer terminals and displays are used in the simulators so they can be easily used and reused.

Figure 6 illustrates the vehicle commander's workstation within a reconfigurable simulator. This particular simulator has been configured to include a digitized target acquisition system called the Commander's Independent Thermal Viewer (CITV) to the front of the commander. An automated C3 device, referred to as the Command and Control Display (CCD), is located to his right.

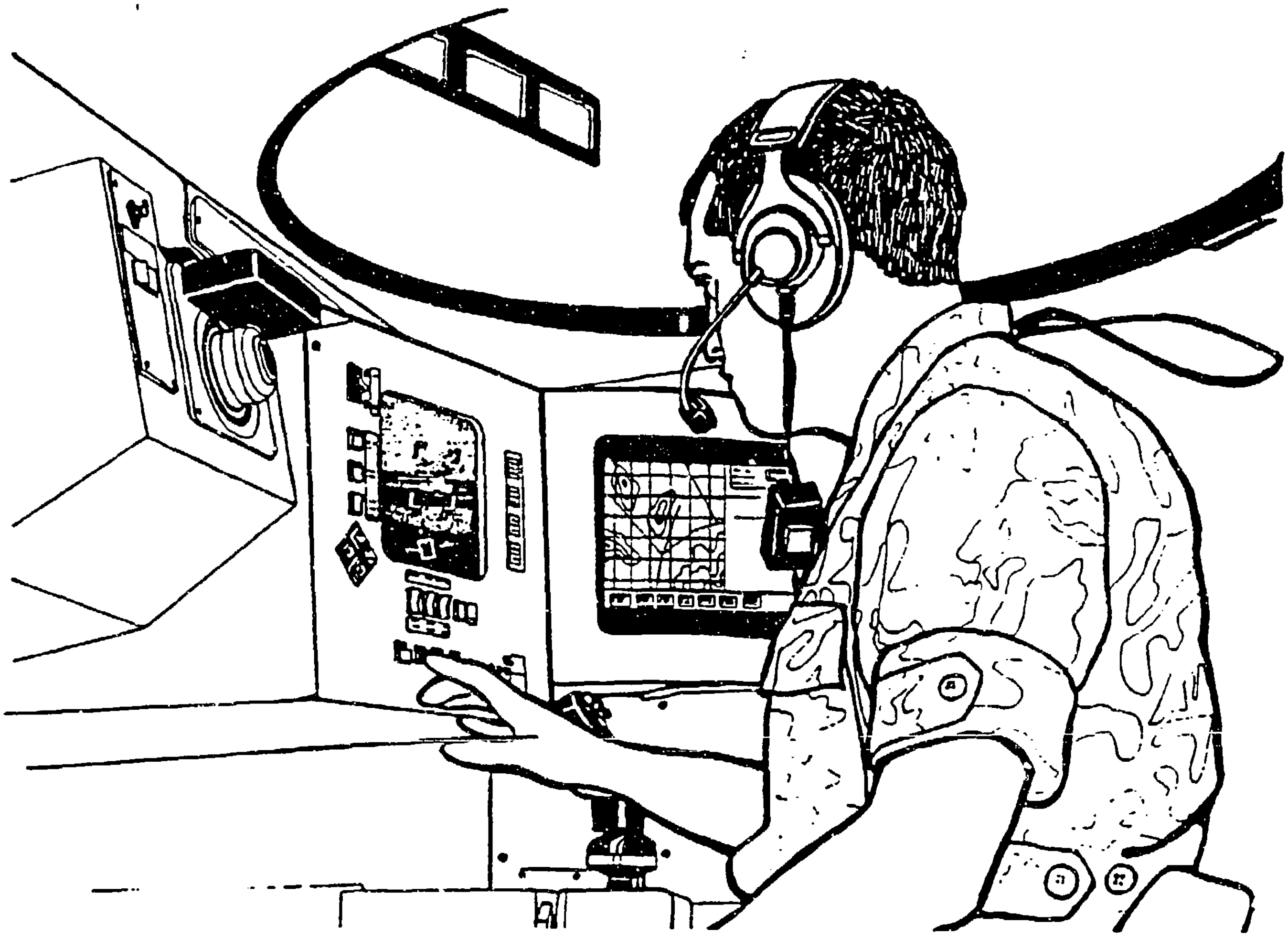


Figure 6. A reconfigurable simulator equipped with digitized target acquisition and automated command, control, and communications device

Both of the devices depicted above, the CITV and CCD, were developed by ARI-Knox for incorporation into the reconfigurable simulator. They are described here as examples of instrumented devices that can be developed and housed in a reconfigurable simulator for use in training.

A close-up drawing of the two instrumented devices is shown in Figure 7. Turning first to the CITV located at the front of the commander's station, this device affords the vehicle commander an independent thermal battlefield viewing capability and an independent laser range finder (LRF). (A more complete description of the CITV can be found in Ainslie et al., 1991.)

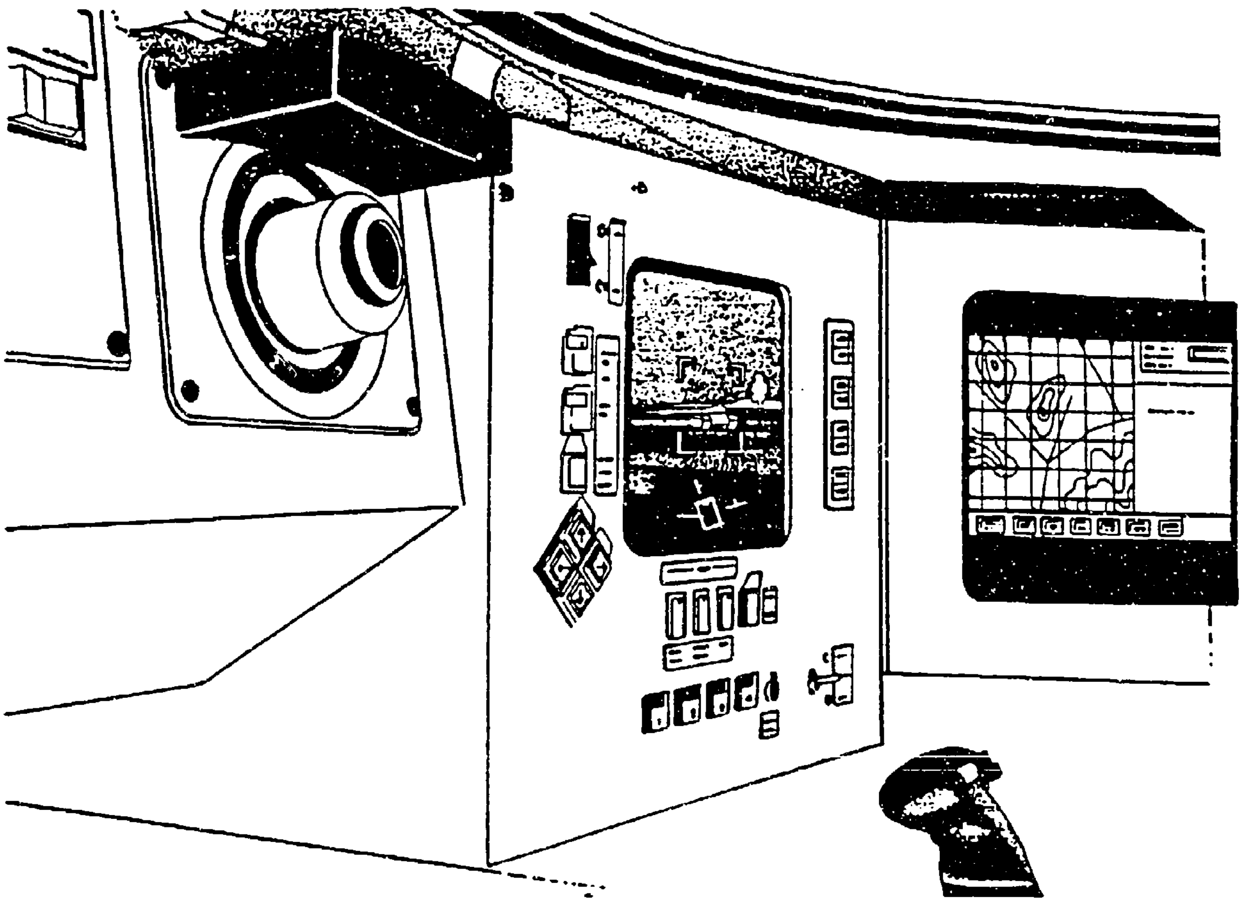


Figure 7. Close-up drawing of the instrumented devices housed within the vehicle commander's crewstation

The vehicle commander controls the operation of the CITV by making inputs through functional switches on the display and through push buttons on his control handle. As shown in Figure 7, control switches are arrayed around three sides of the central display screen. These controls include: a power switch with OFF, STANDBY, and ON positions using a three position toggle switch; push-button selector switches for modes of operation; a two-position, push-button switch for polarity; and autoscan control switches for setting right and left scanning sector limits and adjusting scan rate.

As noted above, the CITV device also includes a commander's control handle as shown in Figure 8. The handle is physically located below the display and in front of the commander's seat. It has push buttons for switching magnification, operating the LRF, and designating targets.

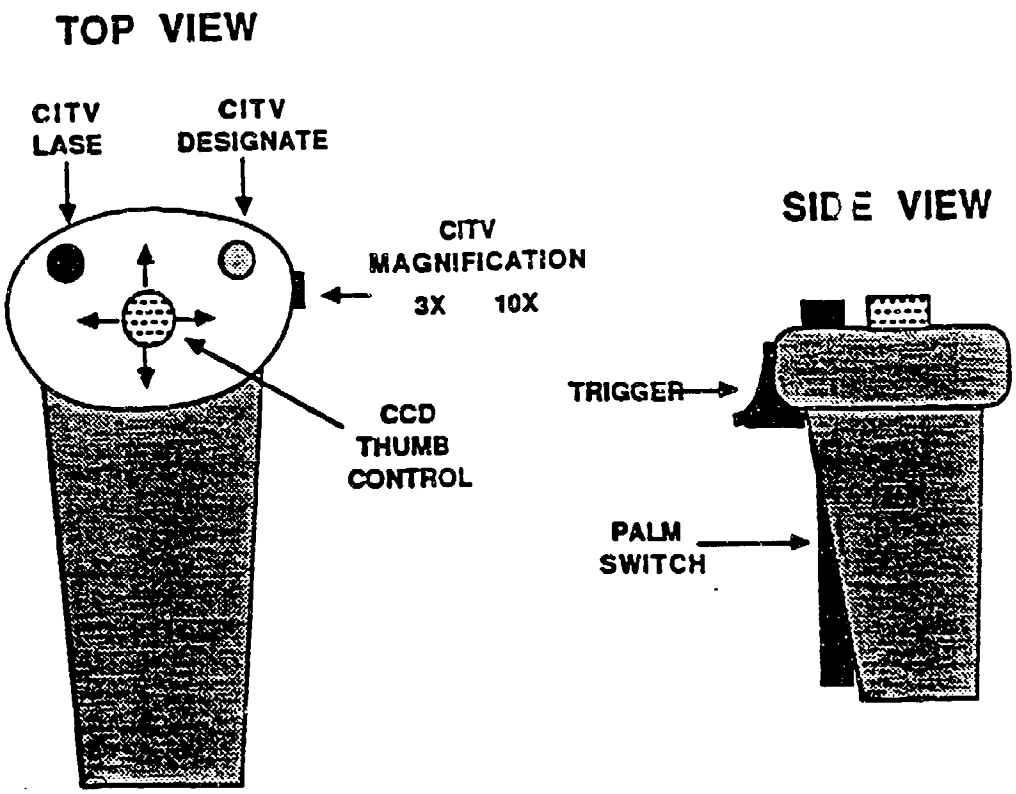


Figure 8. Drawing of the commander's control handle with the functions labeled

A second device which ARI-Knox has developed for use in the reconfigurable M1 simulator is the CCD. This device is housed in a computer display mounted to the right of the vehicle commander. A schematic drawing of the display is shown in Figure 9.

The CCD display has five main functional areas. They include: (a) a full-feature, five-color tactical map with an icon indicating the direction of his vehicle; (b) an information center displaying the date/time group, own grid location, own vehicle heading, and own call sign; (c) a fixed array of dedicated soft-switch menu keys accessing specific functions; (d) a working menu area displaying queue/file listings, sub-menus, and selected functions; and (e) a message receipt alert key. The CCD has three primary sets of functions which can be organized around the tactical map, navigation, and reports.

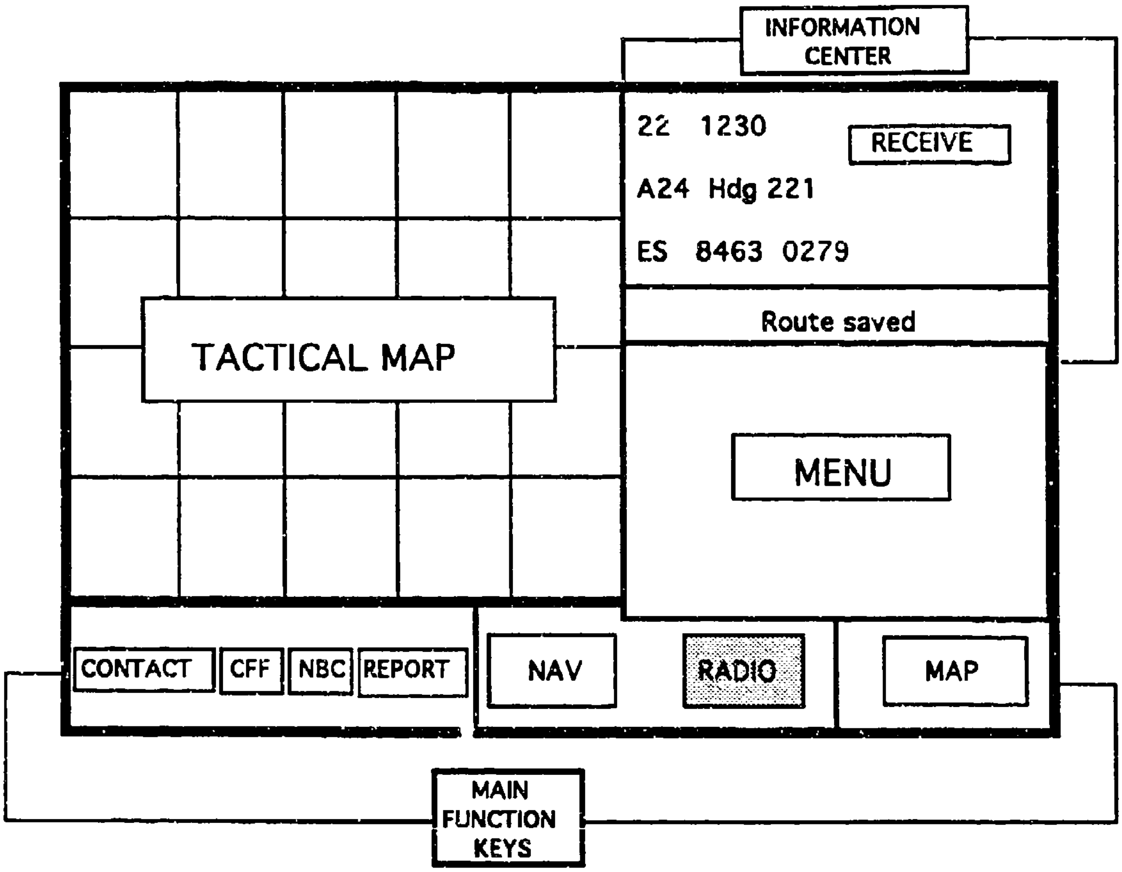


Figure 9. Schematic drawing of the CCD user interface

The CCD tactical map displays the terrain surrounding the tank's location using a UTM grid representation. The map can be adjusted to four different scales and optional terrain features selected for display. The map can also display graphic overlays received digitally and can be scrolled to enable the vehicle commander to set the positioning of the map relative to his tank icon. The map has the capability to display key symbols representing battlefield information including report-based and route-based icons. In addition, the map displays automatically the position of all friendly vehicles equipped with POSNAV located on the terrain segment currently displayed (referred to as "mutual POSNAV").

CCD navigation capabilities assist the vehicle commander in maintaining proper orientation and direction through display of a directional own vehicle icon on the tactical map. The UTM grid location and grid azimuth heading provided in the CCD information center is also designed to assist the commander in this area. The CCD also allows the vehicle commander to create and modify routes (consisting of up to six waypoints) and to send route information to his driver. These routes can also be transmitted digitally to

other vehicles in his unit. In designing this navigation sub-system, ARI-Knox developed a modular Steer-to-Display for the driver's compartment as shown in Figure 10. This display was mounted to the right of the driver's steering column ("T-bar"). It presents alphanumeric information about the tank's current and required heading, as well as distance from the next waypoint on the route.

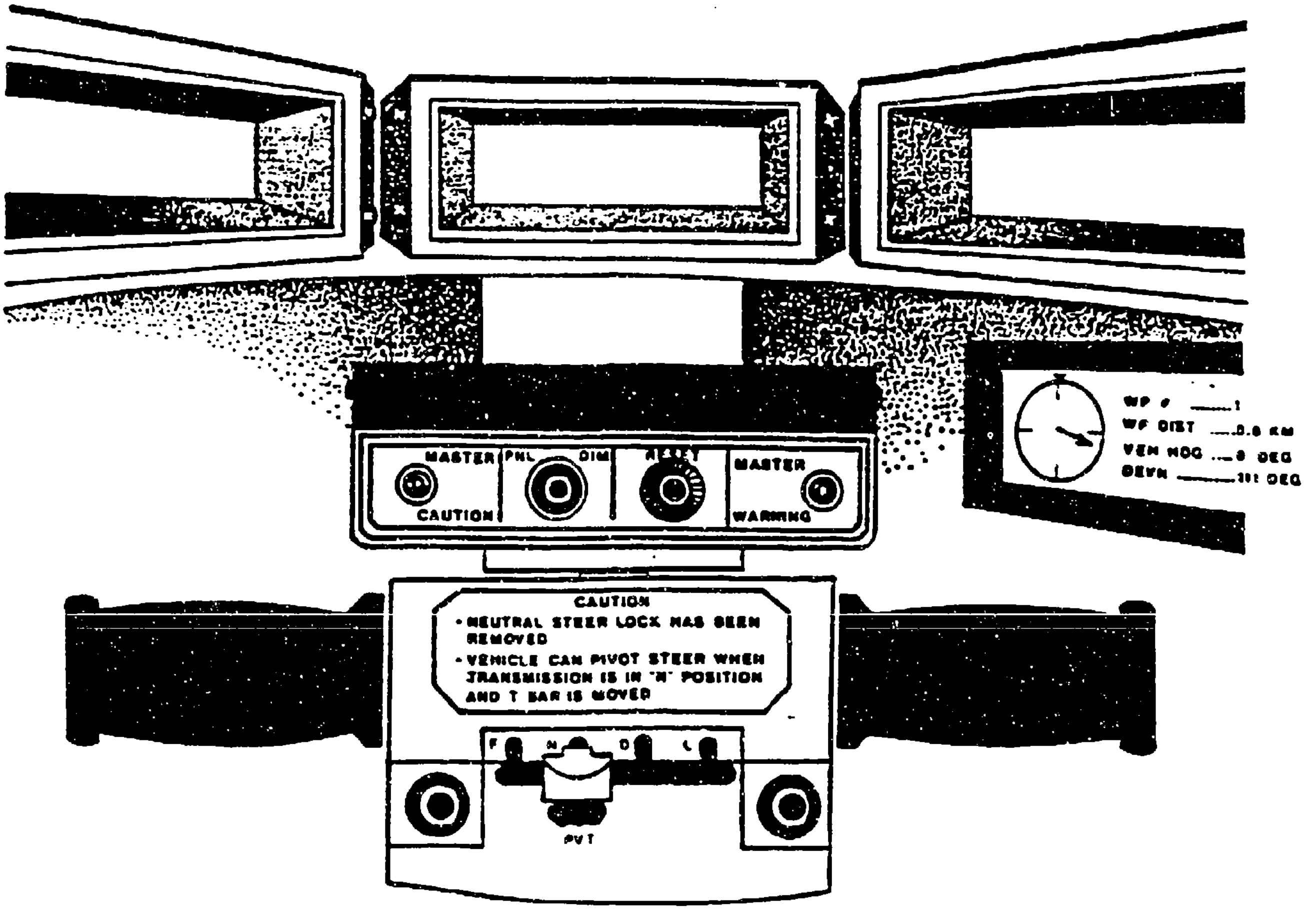


Figure 10. Drawing of the driver's T-bar showing the Steer-to-Display on the right

The CCD also supports the preparation of reports through menu-driven screen forms. Fill-in fields can be entered by selecting inputs from sets of options provided by the CCD. When heading or location information is required, this information can be provided through grid inputs from the tactical map or lasing to a vehicle or terrain point using the CITV. The CCD supports digital transmission and receipt of reports over a simulated radio interface unit.

The vehicle commander controls all CCD functions through a cursor which appears on the display screen. He selects menus and functions by positioning the cursor on the desired key.

Manipulation of the cursor can be accomplished in two ways: (a) touching the face of the touch-sensitive screen with his finger, or (b) using a thumb control mounted on his control handle (see Ainslie et al., 1991 for a full description of the CCD).

The CITV and the CCD serve as examples of the types of prototype devices which can be developed and introduced into vehicle simulators within the DIS environment for use in training exercises. However, in addition to the use of reconfigurable simulators and the development of such prototype devices, there is a third aspect of the development process which is critical and should not be overlooked by potential users. This phase focuses on the specification of desired measures of performance and the implementation of software hooks to capture these data. A major advantage of the DIS environment is the capability to collect automated measures of performance and to analyze these data for use in providing training feedback. But it must be emphasized that when new devices are introduced into simulators, measures must be specified ahead of time and data hook built within the software so that the system is capable of collecting these data later during an exercise.

ARI-Knox has specified automated measures for both the CITV and the CCD and has developed the data hooks needed to capture desired data. These measures are largely intended to capture equipment usage and are identified in Table 9.

Table 9

Automated Equipment Usage Measures

- CCD Usage Measures
  - Percent of inputs by touch screen
  - Number of navigation routes activated
  - Percent of time in each map scale
  - Percent of grid inputs to reports by laser device
  - Median number of report icons on the tactical map
  - Total number of reports originated
  - Percent of reports retrieved from receive queue
  - Percent of reports retrieved
  - Percent of reports relayed, by report type
  - Number of reports relayed
- CITV Usage Measures
  - Percent of time in each operating mode
  - Percent of time in each viewing mode
  - Number of times designate used
  - Number of targets entered in target stack

The data hooks for these measures were developed to generate data packets triggered by the user's activation of the system (e.g., a CCD soft-switch press) or by timed cycles (e.g., sampling every 30 seconds). These data packets are broadcast by each simulator over the Ethernet and are collected, stored and analyzed using the facility's Data Collection and Analysis System. (Currently, the full DCA capability is limited to test-oriented sites such as the Mounted Warfare Test Bed.)

The Data Collection and Analysis System collects, reduces, and analyzes the data packets generated during an exercise and broadcast over the Ethernet by individual simulators. These data packets include those routinely generated by simulators and those for which specialized data hooks have been developed as described above.

Data packets are collected using Data Logger, a mass storage device consisting of both hard disk and magnetic tape recording devices. The Data Logger stores packets directly to disk or tape for use in subsequent analysis or replay on a dedicated display. (This display, called the Plan View Display, is described in a subsequent section of this research product.) Replay capabilities include standard VCR-like capabilities such as fast-forward, freeze and playback starting at a specified time. An additional playback capability is "time travel" which includes the ability to play the exercise back into a simulator and allow the soldiers to drive around the battlefield and observe the exercise from ground level and from any location they choose.

The data analysis system allows recorded data from an exercise to be taken from the Data Logger and ported to a data analysis subsystem running on a Micro VAX computer with high resolution color terminals. Two analysis software programs, DataProbe and RS/1 (both registered trademarks of BBN Software Products Corporation), are designed to extract, organize and analyze data.

DataProbe is an interactive, graphics-oriented data analysis and display software package. It extracts desired data from large quantities of data resident on the system and can be used to perform tabular and graphic analyses. Data can also be relayed to RS/1 for further analysis.

RS/1 contains data base management and statistical analysis features. Once tabulated, data can be rearranged, statistically analyzed, and graphically displayed. Statistical analyses include standard descriptive statistics, as well as inferential statistics such as analysis of variance. Graphic displays include two and three dimensional graphs, bar graphs and pie charts.

In summary, the use of instrumented devices provides a valuable strategy for C3 training; specific applications are discussed in the following section. However, the potential user must keep in mind that the use of such devices requires integration of

four major capabilities within the DIS environment: the reconfigurable simulators, the instrumented device, data hooks for capturing desired automated data, and the data collection and analysis system. The need to carefully specify desired measures of performance related to operation of the device and to implement data hooks to capture them as part of the software development process must be emphasized.

Applications. The use of instrumented devices in a simulation-based environment is a forward looking training strategy. The Combined Arms Training Strategy (CATS) in general and the Armor training strategy as a component of CATS both call for a move toward a device-based training strategy. This approach calls for increasingly greater reliance on simulation for training and limited use of field exercises.

The Coordinating Draft of TC 17-12-7 (Department of the Army, 1991a) lays out the CATS for the Total Armor Force (TAF). The vision for unit training is "to establish an environment which trains armor and cavalry (armored and light) units and commanders to tactically maneuver and to aggressively operate/employ their equipment while objectively evaluating crew through battalion proficiency" (p. 1-6). The TAF view of institutional trainin calls for "train(ing) all TADSS (Training Aids, Devices, Simulators and Simulations) used in the field in the institution" . . . to produce confident, technically proficient leaders and soldiers" (p. 1-11).

Two features of this vision are particularly relevant. First, the expectation is that units and commanders will train with the equipment they will use in the field in a simulation environment. The second is the emph. sis on objective evaluation. The use of instrumented devices supports both of these requirements. Instrumented devices provide a mechanism for incorporating simulated devices into a simulator and for capturing performance data for use in training feedback.

Th specific use of C3 instrumented devices discussed reflects the anticipated fielding of automated, vehicle-based devices to support the C3 process. The IVIS (Intervehicular Information System) Operational Concept published by the U.S. Army Armor Center (Henderson, 1992) also illustrates planning to incorporate such C3 devices into tactics, techniques, and procedures. However, specific training programs to meet these emerging training requirements still await specifications.

It is instructive to note that the training requirements reflect[illegible] in [illegible]erging publications were also recognized by members [illegible] the [illegible]mor and Combined Arms training communities which were interviewed. More specifically, they called for needs for: (a) "plug-in" C3 devices which could be used for training; (b) objective feedback; and (c) training on specific C3 skills requiring use of automated C3 devices such as using voice and digital

communications effectively; managing incoming information appropriately; and maintaining manual skills underlying the use of automated C3 devices.

Training doctrine such as Programs of Instruction (POIs) for institutional training and Mission Training Plans (MTPs) for unit training can be expected to evolve to include tasks explicitly addressing the operation of fielded technology devices and the integration of these devices into battlefield performance. In light of CATS and specific Armor strategies for the TAF, it is likely that instrumented devices will play a major role in strategies adopted to train these tasks.

There are at least two major application areas well suited for instrumented devices for training, These include operator training, likely to occur at the institutional level, and integrated usage of the equipment in a tactical situation, likely to occur at the unit training level.

Operator training is most likely to be conducted in the schools using individual vehicle simulators equipped with the device to be trained. In addition to physical housing of a replica of the device in the simulator along with the software required to make it functional, measures of performance and their associated data hooks would also be implemented. This instrumented device strategy would allow soldiers and leaders to become proficient in the skills necessary to operate the device and to receive objective feedback on their performance. Placing the device within the vehicle simulator adds realism as well as requiring the operator to learn how to operate the device within a similar physical environment as it will ultimately be used.

Figure 11 illustrates one example of operator training using an individual vehicle simulator. Vehicle A12 is equipped with an automated C3 device which supports navigation through route planning on a tactical map. In this case, the operator is being trained in skills for planning routes and transmitting them to another vehicle A11. Numerous other examples corresponding to other functions can be easily imagined.

In cases where time permits, institutional training settings may opt to conduct operator training on stand-alone devices initially. Once operators have become proficient with the stand alone component, they could move to the vehicle simulators equipped with the device for more advanced training. This approach corresponds to the Army's "crawl-walk-run" philosophy of training.

Integrated usage of the equipment in a tactical situation is most likely to occur in a unit training situation. In this setting, it is likely that multiple vehicle simulators would be configured on a network and a tactical scenario developed to drive the training exercise. Each simulator would be equipped with the

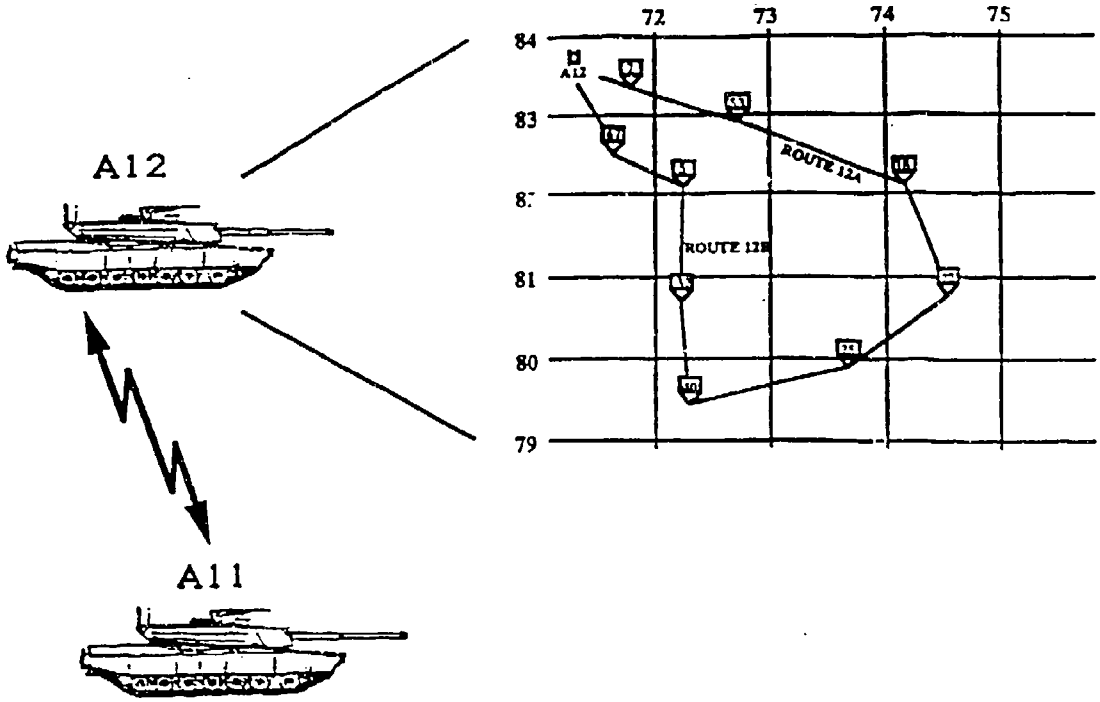


Figure 11. Individual vehicle/vehicle route planning (from IVIS Operational Concept)

instrumented device and use of the device would serve as one skill area to be trained in the course of the exercise.

Figure 12 presents one example in a platoon exercise. In this case, the platoon leader receives the upcoming mission graphics by digital transmission. He is able to begin platoon mission planning and coordination while the company commander refines the tactical plan and graphics. Using the instrumented device, the platoon leader is able to receive information bearing on the platoon fire plan from individual vehicle commanders. He is then able to develop a consolidated direct fire plan using his device which includes these inputs as well as control measures and graphics necessary for the command and control of the platoon. Usage measures incorporated via data hooks in the software would allow feedback to the platoon leader and his subordinates on the effectiveness of their device usage during the planning phase of the mission. This approach could also be applied through the execution of the platoon's mission. Similar exercises at higher echelons could also be structured along these lines.

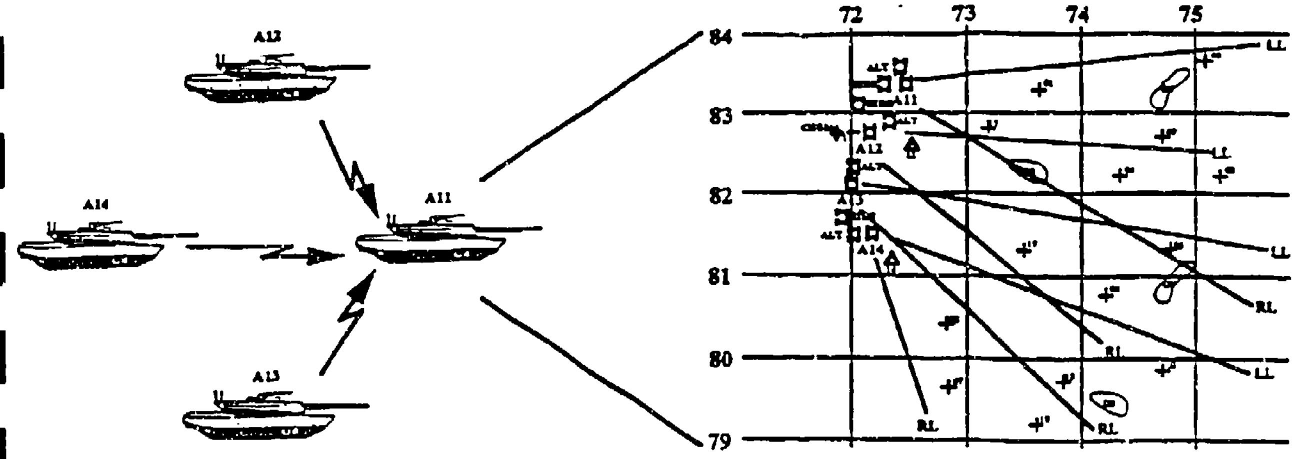


Figure 12. Platoon - consolidated vehicle directed fire sketches (from IVIS Operational Concept)

In summary, the use of instrumented devices for training is likely to become widespread as CATS and the move toward a device-based training strategy becomes implemented. Instrumented devices provide a cost-effective approach for training skills on equipment operation and their integration within a tactical situation using a simulation-based environment. Furthermore, they offer the advantage of providing objective measures of performance which can be collected from the automated data stream for use in training feedback.

Resources. There are two major sets of documents which potential users may wish to consult. The first describes ARI-Knox's development of two instrumented devices, the CITV and the CCD:

Ainslie, F.M., Leibrecht, B.C., & Atwood, N.K. (1991). Combat vehicle command and control systems: III. Simulation-based company evaluation of the soldier machine interface (SMI) (Technical Report 944). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

The interested user should note that this report describes prior development activities by ARI-Knox in the instrumented device domain and provides additional references.

The second set of references describes supporting capabilities in the DIS environment including reconfigurable simulators and the data collection and analysis system:

Garvey, R.E., Radgowski, T., & Heiden, C.K. (1988). SIMNET-D standing operating procedure (Report No. 6929). Cambridge, MA: BBN Systems and Technologies Corporation.

Interested users may also wish to consult an unpublished paper available in the Fort Knox DIS facility or from ARI-Knox which provides additional information in these areas:

Radgowski, T. & Garvey, R.E. (undated). SIMNET-D: Combat modeling through interactive simulation. Cambridge, MA: BBN Systems and Technologies Corporation.

SEND Utility

The SEND utility is a software tool for creating and sending digital messages to vehicle simulators or Battalion Tactical Operations Center (Bn TOC) workstations within the DIS environment. SEND offers numerous advantages to trainers including the capability to simulate message traffic with minimal personnel requirements, to standardize the conditions for vehicle-based training as well as the training of battalion staff, and to deliver training concurrently to multiple individuals assigned to the same position.

Capsule Description. The SEND utility is a software program which runs on a SPARCS workstation. SEND is intended to be used in conjunction with an automated command and control display that allows digital messaging and is housed in a vehicle simulator and/or a Bn TOC workstation which allows the receipt of digital reports.

The SEND utility can be used to create and transmit seven types of digital reports including: Call for Fire (CFF), Contact, Shell, Situation, Spot, Intel and free text. When a file for a specific report is created using SEND, it contains the following identifying information in addition to the type of report and the information particular to that report:

1. The network over which the report is to be sent;

2. The call sign for the duty position of the report originator;

3. The relevance of the report (designated as high, medium, low); and

4. A unique identification number assigned by the originator to identify the report.

SEND can be used to create an individual report (called a SEND file), to sequence multiple reports and to specify the timing of their delivery (called a VIGNETTE file), and to group individual reports and vignettes into larger sessions (called a SESSION file). This development is generally accomplished prior to a training exercise. However, individual reports (SEND files) can be created interactively in real time during an exercise to sup-

port training delivery. However, in this case, files cannot be saved for future use.

Creating a SEND file is a simple matter of naming the file and entering the type of information to be contained in the report. Table 10 shows a SEND file for a contact report sent by a platoon wingman (A23). Here he is reporting two contact incidents (a tank and ATGM) with their appropriate grid locations.

Table 10

A Typical Contact Report File

originator	**A23**
relevance	**high**
identifier	**01**
report	**contact**
what-0	**tank**
location-0	**ES849398**
what-1	**ATGM**
location-1	**ES852932**

To create a vignette file, the user must list the SEND files to be included in the vignette and specify the time interval in seconds between transmission. If desired, the user can specify multiple time intervals within a vignette so that reports are sent at different intervals as shown in Table 11. If no time interval is specified, the system defaults to a one second interval between messages. Messages can also be timestamped by specifying an h-hour. The h-hour can be used to specify either the start time for the first report or the end delivery time for the last report. The system then computes a time stamp for each report in the vignette using the h-hour and the interval size. Thus, reports can be timestamped and sent in the past or in the future. If an h-hour is not specified, the system uses the current time as the timestamp for the first report and timestamps subsequent reports using the interval size (see Table 11).

Session files are simply larger files composed of multiple vignettes or individual reports. A Session file can be created by specifying the type of file (Session), listing the Vignette Files and SEND files to be included and the network over which the Session File is to be sent.

In addition to file creation functions, the SEND utility includes several specialized functions to assist the user during a training exercise. These include the capability to add files to the queue for sending, delete files from the queue so they are not sent, view files which are waiting in the queue, and execute or send files. As noted earlier, it is also possible to create new files during the exercise and add them to the queue if the need arises.

Table 11

Time Stamping of Vignette Files (from CVCC Utilities User Manual)

```
Example 1 (now = 27 Jul 9:00:00):

  vinette
  hhour first now
  interval 15
  report 1     (timestamp = 27 Jul 09:00:00)
  report 2     (timestamp = 27 Jul 09:00:15)
  report 3     (timestamp - 27 Jul 09:00:30)
  interval 10
  report 4     (timestamp = 27 Jul 09:00:40)
  report 5     (timestamp = 27 Jul 09:00:50)

Example 2:

  vignette
  hhour last 25 Jul 10:00:00
  Interval 5
  report 1     (timestamp = 25 Jun 09:58:35)
  report 2     (timestamp = 25 Jun 09:58:40)
  report 3     (timestamp = 25 Jun 09:58:45)
  report 4     (timestamp = 25 Jun 09:58:50)
  interval 10
  report 5     (timestamp = 25 Jun 09:59:00)
  interval 20
  report 6     (timestamp = 25 Jun 09:59:20)
  report 7     (timestamp = 25 Jun 09:59:40)
  report 8     (timestamp = 25 Jun 10:00:00)
```

Applications. The SEND utility has several applications to training delivery and to emerging training requirements. Use of SEND offers many of the features required for future training delivery called out in our interviews with members of the Army training community at Fort Knox and Fort Leavenworth and noted by the Director of Training Development in the most recent Armor Conference. (See introductory section of this Research Product.) The training delivery needs which the SEND utility addresses directly include: (a) improved training efficiency (since needs for training personnel are reduced through automated messaging); and (b) increased training standardization (since reports can be saved and used in repeated exercises). In addition, efficiency and standardization gains are also achieved using SEND since exercises can be structured so that individuals participate concurrently in the same positions and receive the same messages.

The use of SEND within the DIS environment has broad training applications. These applications include both vehicle-based training and Tactical Operations Center (TOC) training at both the institutional and unit level.

For vehicle-based training, training requirements in the C3 area, particularly in training information management skills, are well suited to the use of SEND in a DIS environment. The increasing importance of training soldiers and leaders to manage incoming information effectively was emphasized in our interviews with members of the Armor training community. Furthermore, as automated C3 devices become fielded within combat vehicles, these skills can be expected to take on even greater prominence.

Vehicle-based training of information management skills is schematically illustrated in Figure 13. This diagram illustrates how the SEND station can be used to transmit messages to vehicle simulators. These simulators can be initialized to the same position (e.g., B11) to increase training standardization and efficiency. Leaders training within each of these simulators then receive the same message traffic which they must process and act upon.

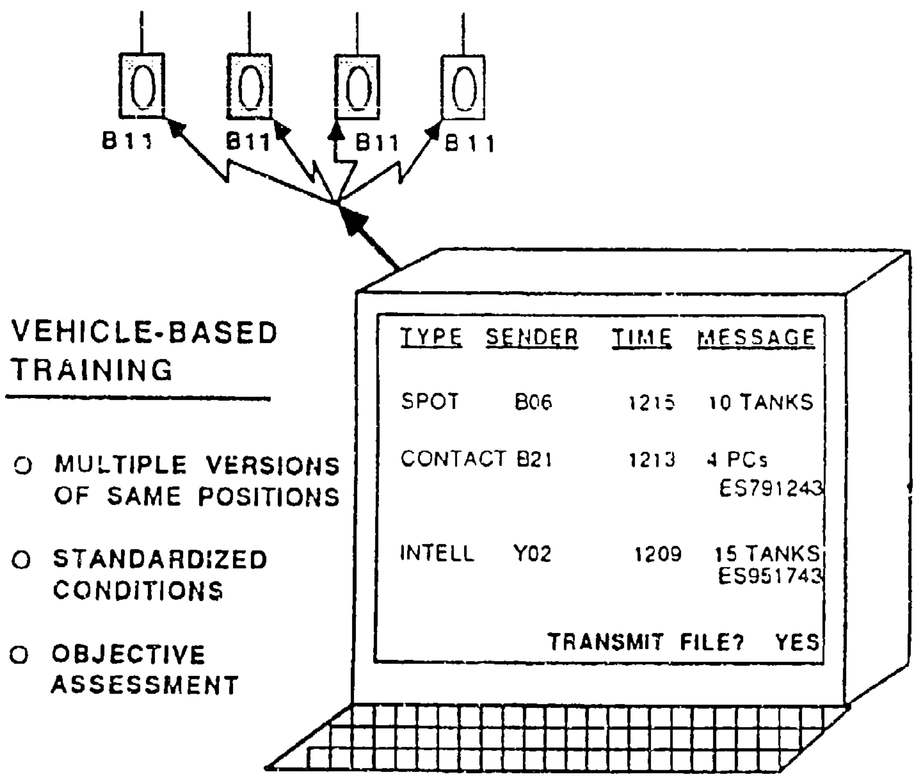


Figure 13. Use of SEND for vehicle-based training

This type of exercise is well suited to institutional training in courses where large numbers of students are being prepared for specific positions. For example, students from AOBC might productively participate in such a training exercise as platoon leaders. Students from the AOAC would more appropriately participate as company commanders. While the AOBC and AOAC POIs do not currently include information management tasks as training objectives, it is reasonable to expect that future updates will address these skills in light of anticipated fieldings of automated C3 equipment.

An information management training exercise using SEND in a DIS environment is also well suited to unit training of leaders and soldiers. Again, while current Mission Training Plans (MTPs) do not explicitly call out information management tasks for training, skilled performance of these tasks will be required with the fielding of automated C3 devices.

Lickteig (1992) pioneered the design of training on information management in the DIS environment using SEND. Lickteig trained multiple tank commanders on C3 tasks by using SEND to vary the relevance and number of transmitted messages received by each vehicle commander. To structure these message sets, he developed the individual messages using the SEND utility, placed them in a common directory, and grouped them together to form vignettes. Unique message sets (vignettes) were transmitted to each vehicle commander by specifying different radio nets to each vignette. Lickteig also incorporated situational awareness measures into the training exercise to objectively assess the vehicle commander's ability to "see the battlefield" and to incorporate relevant information received through digital messaging into his view. The latter feature offers the added advantage of providing a basis for objective feedback, another training requirement consistently highlighted in our interviews with the Army training community.

More recently, ARI-Knox has extended Lickteig's work and has developed an Information Management Exercise (IMEX) for use in training information management skills. The IMEX uses a network of four student workstations and one training coordinator workstation. Each student operates in the role of a company commander. The exercise is organized into four vignettes, each focused on specific information management training objectives. SEND is used to transmit messages to students for receipt, processing, and dissemination. All students receive the same message set for a particular vignette contributing to training standardization. Vignettes are structured to become progressively more difficult by increasing the number of messages transmitted within a fixed time period. SEND is also used by the training coordinator to transmit special training messages to students. Student performance is assessed through preparation of a Situation Report, completion of situational awareness measures, and participation in an AAR led by the training coordinator and organized around the training objectives for the vignette. As in Lickteig's exercise, this approach builds in objective data which can be used for

providing feedback to students on their performance (see Winsch, et al. in preparation, for a more detailed description of the IMEX and copies of training materials).

The SEND utility also offers a valuable tool for delivering training to battalion staff officers operating in a TOC. As shown in Figure 14, SEND provides stimuli upon which staff members must respond in performing their tasks and operating as an integrated staff.

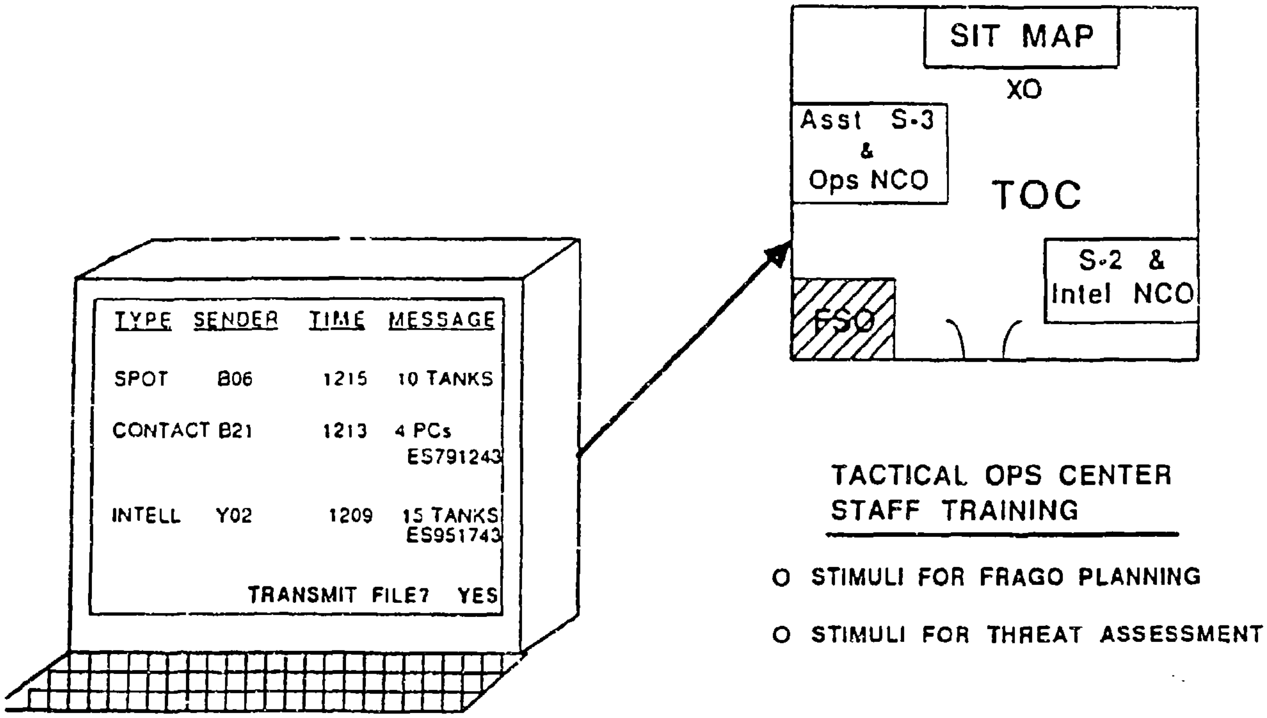


Figure 14. Use of SEND utility for tactical operations center staff training

The need for more effective battalion staff training was noted in our interviews, particularly from members of the Combined Arms training community at Fort Leavenworth. Training these skills is the focus of both institutional training and unit training. For example, one of the goals of AOAC is to train Armor officers for battalion staff positions. The Program of Instruction (POI) for this course includes training objectives focused on performance of tasks associated with particular staff positions. For example, Intelligence Preparation of the

Battlefield (IPB) (the Intelligence Officer's, S-2's, responsibility), and the mission analysis process including preparation and issuing of warning orders and developing the operations estimate (functions of the Operations Officer, S-3), are specifically addressed in the small group instruction provided by the Command and Staff Department.

Similarly focused training, generally within the context of larger collective exercises, is called for in unit training. For example, the Mission Training Plan for the Tank and Mechanized Infantry Battalion Task Force, ARTEP 71-2-MTP (Department of the Army, 1988b) identifies specific tasks and subtasks for battalion staff which must be performed to standard. For example, the task "Perform S3 Operations" includes subtasks related to maintaining communications, issuing warning orders, collecting information and updating the estimate and issuing FRAGOs among others. The task "Perform S2 Operations" includes subtasks such as preparing the intelligence estimate and situational/event templates locating likely enemy positions, courses of action and weaknesses among others.

These skills are well suited to training with SEND in a DIS environment. As noted in Figure 15, the SEND utility can be used to transmit messages to staff officers that serve as stimuli for S-3 functions such as FRAGO planning and for S-2 functions such as threat assessment.

In summary, the SEND utility coupled with other capabilities within the DIS environment provides a useful tool for delivering both vehicle-based and TOC-oriented training. SEND offers the advantages of minimizing the personnel required to run a training exercises through automated messaging, using training time efficiently by providing concurrent training to multiple individuals participating in a specific position and for standardizing the training process through development of established messages which can be ordered into vignettes and larger sessions for repeated use in training exercises.

Resources. The SEND utility is fully documented in a User's Manual which provides operational instructions:

Bolt, Beranek & Newman, Inc. (1992). CVCC utilities user manual. Cambridge, MA: LBN Systems and Technologies.

Users interested in particular applications of SEND are encouraged to consult the two references below which provide detailed descriptions of the use of SEND for training purposes:

Lickteig, C. (1992). Prototype methods for training and assessing future tactical command and control skills (ARI Research Product). Alexandria, VA: U.S. Army Research Institute for the Social and Behavioral Sciences.

Winsch, B.J., Atwood, N.K., Sawyer, A.S., Quinkert, K.A. Heiden, C.K., Smith, P.G., and Schwartz, B. (In preparation) Innovative training concepts for use in Distributed Interactive Simulation (DIS) environments (ARI Research Product). Alexandria, VA: U.S. Army Research Institute for the Social and Behavioral Sciences.

LISTEN Utility

The LISTEN utility is most commonly used as a companion to the SEND utility. LISTEN is designed to monitor messages transmitted over the network, present them on a screen display and send them to a printer. Thus, LISTEN offers the capability to provide objective feedback to students by generating hard copies of their message traffic for subsequent discussion or review.

Capsule Description. LISTEN is housed on a dedicated workstation. When the utility is activated, the system monitors the ethernet linking the simulators for message packets. As messages being sent over the network are identified, they are displayed on the workstation screen. These messages are also sent to the printer for the creation of hard copies. The LISTEN output may also be saved to a disk file for later review if desired.

Table 12 provides an example of the output of the LISTEN station. As illustrated, the output identifies the time and exercise as well as the sender, a report number, the nature of the report, and the content of the report. In this case, the message was a Contact Report with a tank originating from A24.

Table 12

LISTEN Station Output of a Contact Report

13:22:05 Exercise 3: Datagram sent on Ethernet by 0/0/0
Report (0/0/0-31125) transmitted on 1/Bn network by A24
Contact report 31125 created by A24 at 13:22:05
[What: TANK Location: ES832882]

Finally, it should be noted that the LISTEN station can also be used to monitor and record event flags created using the Plan View Display (PVD). The PVD is the subject of a subsequent section and the reader is referred there for further discussion.

Applications. The LISTEN station has two primary applications. It provides a tool for monitoring message traffic in real time during an exercise and it offers a mechanism for capturing reports for later use in training feedback. Both of these capabilities contribute to the development of objective feedback for trainees on their performance, a requirement that received

considerable attention in our interviews with the Army training community.

The IMEX described in the preceding section illustrates how the LISTEN utility can be incorporated into a training exercise. During the IMEX vignettes, the training coordinator is able to monitor the screen of the LISTEN station to follow student performance during an exercise and to identify any immediate needs for intervention. Reports generated by students participating in the IMEX are also printed for subsequent use by calling upon the LISTEN utility.

The output from LISTEN is used in two major ways. First, the reports generated by students are discussed in After Action Reviews (AARs) organized around the specific training objectives for the vignette. Second, hard copies of student's reports are organized into an Exercise Package which includes background materials such as the training objectives and the OPORD extract as well as feedback on report actions generated by Subject Matter Experts (SMEs). Thus, the Exercise Package provides a written record for students to which they can refer later for subsequent study and review.

In summary, the LISTEN utility provides an easily used tool for capturing message traffic during an exercise. LISTEN allow for real time monitoring during an exercise as well as the generation of hard copies for later use. Use of LISTEN contributes directly to the generation of more objective feedback for use in training exercises.

Resources. A brief section on the LISTEN utility is included in the User Manual for CVCC utilities:

Bolt, Beranek & Newman, Inc. (1992). CVCC utilities user manual. Cambridge, MA: BBN Systems and Technologies.

Control Measure Performance Measurement System

The Control Measure Performance System was developed by ARI-Knox to allow assessment of the effectiveness of C3 performance through a comparison of the extent to which the maneuver of blue force units corresponded to the control measures established by headquarters. The system relies on the components available in the DIS environment to collect, extract and summarize automated data on unit performance. These components include the DataLogger system which captures and records all data packets from the simulation stream, the DataProbe system which extracts packets of interest from the full set of data packets, and the RS/1 Analysis system which can be used to produce data summaries. (Data Logger,

Data Probe, and RS/1 are registered trademarks of BBN Software Products Corporation.)

At the present time, the DataProbe and RS/1 systems are analytic tools which are available in test-oriented facilities such as the Mounted Warfare Test Bed (MWTB) at Fort Knox. They are not currently available at training-oriented facilities. Thus, the use of the Control Measure Performance Measurement System is limited to facilities such as the MWTB with a full automated data collection and analysis capability. However, these measures offer potential for use in training-oriented sites as their automated data collection and analysis capabilities are expanded either through the addition of current system components (DataProbe and RS/1) or the acquisition of newer automated data collection and analysis systems anticipated to be available in the near future. The latter systems include the SIMNET Unit Performance Assessment System (UPAS) currently under development as a collaborative effort between ARI-Knox and the ARI Field Unit at Orlando (Meliza et al., 1992) and the Close Combat Tactical Trainer (CCTT) currently under development by the U.S. Army.

Capsule Description. The Control Measure Performance Measurement System is designed as a strategy for gathering data on the effectiveness of C3 at the battalion level. The approach taken was to define a strategy for extracting data from the automated data stream which could be used to compare the correspondence between the control measures established by battalion headquarters and the actual maneuver of subordinate blue force units.

Control measures are integral to the C3 process. As part of the mission planning process, Operations Plans and associated overlays are prepared by battalion and issued to subordinate units. These documents identify two main components: the planned scheme of maneuver for the mission (including required fire support planning) and the control measures designated to assist in the command and control of subordinate units.

Control measures have been standardized for use in the U.S. Army as well as in the North Atlantic Treaty Organization (NATO). Commonly used control measures are identified in Table 13.

The performance measurement system is designed to collect data on the extent to which the actual maneuver of subordinate units corresponded to established control measures such as those identified in Table 13. Key data elements include:

1. Boundaries. Violation of assigned boundaries by any element of a unit is recorded. Specific information required is:

    (a) Unit or element(s) violating boundaries.
    (b) Time the violation occurred.
    (c) Location at which violation occurred.

Table 13

Control Measures

Lines	
Boundaries	Line of Departure
Routes	Phase Lines
Restrictive Fire Line	Limit of Advance
Forward Line of Own Troops (FLOT)	Forward Edge of the Battle Area (FEBA)
Fire Support Coordination Line (FSCL)	Front Lines
Points	
Coordinating Point	Contact Point
Strat Point	Release Point
Strong Point	Checkpoint
Linkup Point	Passage Point
Point of Departure	Rally Point
Traffic Control Point	

2. Line of Departure. Record crossing of the Line of departure by a subordinate element.

   (a) Time the Line of Departure was crossed.
   (b) The location where the Line of departure was crossed.
   (c) The unit which has crossed the line of departure.

3. Routes. Recording of deviations from a specific route designated to be followed by subordinate unit.

   (a) Time the deviation from the route began.
   (b) Time the deviation from the route ended.
   (c) Unit deviating from its assigned unit.
   (d) Distance of deviation from the route (center of mass of the deviating unit).

4. Phase Lines. Record the reaching/crossing of phase lines by subordinate units.

   (a) Identification of the unit and the phase line.
   (b) Location at which the phase line was reached.
   (c) Time at which the lead element reached the phase line.
   (d) If unit halted, time unit resumed movement after crossing the phase line.

5. Restrictive Fire Line. Record any fires crossing a restrictive fire line.

   (a) Time at which either direct or indirect fires were delivered across a restrictive fire line.

(b) Location at which fires crossed a restrictive fire line.
(c) Unit delivering the fires across a restrictive fire line.
(d) Number of rounds delivered across the restrictive fire line.
(e) Identification of any targets struck by the fires.

6. Limit of Advance. Record arrival of units at a limit of advance line and any violation thereof.

(a) Time of arrival of the unit at the Limit of Advance Line.
(b) Identification of the Unit in (1) above.
(c) Time unit crosses the Limit of Advance Line.
(d) Identification of the element crossing the Limit of Advance Line.
(e) Distance by which the unit crossed the Limit of Advance Line.

7. Forward Line of Own Troops (FLOT). Record arrival at and crossing of the FLOT by Blue Force troops.

(a) Time of arrival of the unit at the FLOT.
(b) Identification of the Unit in (1) above.
(c) Time of crossing of the FLOT by blue force units.
(d) Identification of the element first crossing the FLOT.

8. Forward Edge of the Battle Area (FEBA). Record arrival at and crossing of the FEBA.

(a) Time of arrival of the unit at the FEBA.
(b) Identification of the Unit in (1) above.
(c) Time of crossing of the FEBA by blue force units.
(d) Identification of the element first crossing the FEBA.

9. Fire Support Coordination Line (FSCL). Record direct and indirect fires delivered by Blue Forces across an FSCL.

(a) Time at which direct and indirect fires are delivered across an FSCL.
(b) Type of fires in (1) above.
(c) Unit delivering the fires in (1) above.
(d) Number of rounds delivered in (1) above.
(e) Identification of targets struck by fires in (1) above.

10. Front Lines. Record units which move forward of the front line trace of the blue force units.

(a) Time at which Blue Force Unit moved forward of the front line trace of BLUFOR forces.

(b) Identification of BLUFOR unit moving forward of the BLUFOR front line trace.

11. Coordinating Point. Record arrival and departure of a BLUFOR element at a Coordinating Point.

(a) Time at which a BLUFOR element arrived at a coordinating point.
(b) Location of the coordinating point.
(c) Identification of the BLUFOR element at the coordination point.
(d) Time at which the BLUFOR element departed the coordination point.

12. Contact Point. Record arrival and departure of a BLUFOR element at a Contact Point.

(a) Time at which a BLUFOR element arrived at a contact point.
(b) Location of the contact point.
(c) Identification of the BLUFOR element at the contact point.
(d) Time at which the BLUFOR element departed the contact point.

13. Start Point. Record arrival and departure of a BLUFOR unit at a Start Point.

(a) Time at which a BLUFOR element arrived at a start point.
(b) Location of the start point.
(c) Identification of the BLUFOR element at the start point.
(d) Time at which the BLUFOR element departed the start point.

14. Release Point. Record arrival and departure of a BLUFOR element at a Release Point.

(a) Time at which a BLUFOR element arrived at a release point.
(b) Location of the release point.
(c) Identification of the BLUFOR element at the release point.
(d) Time at which the BLUFOR element departed the release point.

15. Strongpoint. Record arrival and departure of a BLUFOR element at a strongpoint.

(a) Time at which a BLUFOR element arrived at a strongpoint.
(b) Location of the strongpoint.

(c) Identification of the BLUFOR element at the strongpoint.
(d) Time at which the BLUFOR element departed the strongpoint.

16. Checkpoint. Record arrival and departure of a BLUFOR element at a checkpoint.

    (a) Time at which a BLUFOR element arrived at a checkpoint.
    (b) Location of the checkpoint.
    (c) Identification of the BLUFOR element at the checkpoint.
    (d) Time at which the BLUFOR element departed the checkpoint.

17. Linkup Point. Record arrival and departure of a BLUFOR element at a Linkup Point.

    (a) Time at which a BLUFOR element arrived at a linkup point.
    (b) Location of the linkup point.
    (c) Identification of the BLUFOR element at the linkup point.
    (d) Time at which the BLUFOR element departed the linkup point.

18. Passage Point. Record arrival and departure of a BLUFOR element at a Passage Point.

    (a) Time at which a BLUFOR element arrived at a passage point.
    (b) Location of the passage point.
    (c) Identification of the BLUFOR element at the passage point.
    (d) Time at which the BLUFOR element departed the passage point.

19. Point of Departure. Record arrival and departure of a BLUFOR element at a Point of Departure.

    (a) Time at which a BLUFOR element arrived at a point of departure.
    (b) Location of the point of departure.
    (c) Identification of the BLUFOR element at the point of departure.
    (d) Time at which the BLUFOR element departed the point of departure.

20. Rally Point. Record arrival and departure of BLUFOR elements at a Rally Point.

    (a) Time at which each BLUFOR element arrived at a rally point.

(b) Location of the rally point.
(c) Identification of each BLUFOR element upon arrival at the rally point.

21. Traffic Control Point. Record arrival and departure of a BLUFOR element at a Traffic Control Point.

(a) Time at which a BLUFOR element arrived at a traffic control point.
(b) Location of the traffic control point.
(c) Identification of the BLUFOR element at the traffic control point.
(d) Time at which the BLUFOR element departed the traffic control point.

In each case, arrival within 200 meters of a linear control measure and 100 meters of a point control measure is considered as an accurate arrival.

The system also records BLUFOR unit movements to and from key areas identified by control measures. These areas are shown in Table 14.

Table 14

Area Locations for Control Measures

No-fire Areas	Objective Areas
Assembly Areas	Restrictive Fire Areas
Free Fire Areas	
Battle Positions	

For each of the control measures shown in Table 14 the following specific information is recorded:

1. No-fire Areas (NFA). Record the volume, location and type of fires delivered into a NFA and the unit delivering such fires.

(a) Time at which direct and indirect fires are delivered into a NFA.
(b) Type of fires delivered into the NFA.
(c) Unit delivering the fires into the NFA.
(d) Number of rounds delivered into the NFA.
(e) Identification of targets struck by fires in the NFA.

2. Objective Areas. Record the arrival of BLUFOR units on assigned objectives.

   (a) Time at which the BLUFOR unit arrives on an assigned objective area.
   (b) Location of the objective area.

3. Assembly Areas. Record the arrival and departure of BLUFOR units into and out of an assembly area.

   (a) Time at which the BLUFOR unit arrives at an assembly area.
   (b) Location of the assembly area.
   (c) Time the BLUFOR unit lead element departs the assembly area.

4. Restrictive Fire Areas (RFA).

   (a) Time at which direct and indirect fires are delivered into an RFA.
   (b) Type of fires into the RFA.
   (c) Unit delivering the fires into the RFA.
   (d) Number of rounds delivered into the RFA.
   (e) Identification of targets struck by fires in the RFA.

5. Free Fire Areas (FFA).

   (a) Time at which direct and indirect fires are delivered into a FFA.
   (b) Type of fires into the FFA.
   (c) Unit delivering the fires into the FFA.
   (d) Number of rounds delivered into the FFA.
   (e) Identification of targets struck by fires in (1) above.

6. Battle Positions. Record the time and location when BLUFOR units arrive and/or depart battle positions.

   (a) Time a BLUFOR unit arrive in a battle position.
   (b) Identification of the unit in the battle position.
   (c) Location of the battle position.
   (d) Time a BLUFOR unit departs from a battle position.

The control measure performance measurement system provides automated data on the quality of mission execution. These measures provide important input into AAR discussions on the correspondence between mission plans and execution.

Applications. The primary application of the control measure performance measurement system is in the execution of a battalion-level exercise in the DIS environment. The system provides a mechanism for assessing the degree to which subordinate units

within the battalion maneuvered in accordance with their designated control measures. This correspondence provides an indirect measure of the effectiveness of the C3 system since close correspondence indicates that the units were performing as intended by higher headquarters.

Feedback from the control measure performance measurement system may be usefully incorporated into an After Action Review (AAR) or written exercise report. These performance measures provide insights into the effectiveness of the battalion C3 system and the extent to which subordinate units were able to comply with their designated control measures.

Resources. Primary resources on the automated data collection system include User's Manuals for the three components of the system: (a) DataLogger; (b) DataProbe; and (c) RS/1.

Bolt, Beranek & Newman, Inc. (1988). SIMNET data collection and review. Cambridge, MA: BBN Systems and Technologies Corporation.

Bolt, Beranek & Newman, Inc. (1986). Data Probe™ user's manual, version 8.0. Cambridge, MA: BBN Laboratories, Inc.

Bolt, Beranek & Newman, Inc. (1988). RS/1 user's guide. Cambridge, MA: BBN Software Products Corporation.

Approaches for Demonstration, Presentation and Analysis

Overview

The DIS environment offers valuable capabilities for demonstrating key teaching points, presenting and replaying battlefield events for presentation and feedback purposes, and for analyzing performance using data gathered from the automated data stream or by video capture. The simulation environment thus allows for more powerful demonstrations, more accurate and comprehensive exercise monitoring, and more objective feedback using observable measures of performance than is normally possible in the field. In addition, since data can be saved for subsequent analysis, the opportunity for deriving lessons learned is also a potential.

Specifically, this section describes three important tools for use in demonstration, presentation and analysis. They include: (a) the Plan View Display; (b) the Stealth; and (c) Mini Cameras.

Plan View Display

The Plan View Display (PVD) is a standalone workstation that provides a real-time display of the battlefield. This display

shows all manned simulators and unmanned vehicles for both the BLUFOR and OPFOR allowing real-time observation of battlefield events. In addition, the "birds eye top-down view" display shown on the PVD can be used to flag events for subsequent analysis and to replay exercises for use in demonstrating key teaching points. These capabilities provide for training feedback or review at a later time for more in-depth analysis.

Capsule Description. A schematic drawing of the PVD is shown in Figure 15. As illustrated, the PVD has five major components. The first is the map display which constitutes the largest portion of the screen. The map display provides a color-coded, two dimensional view of the battlefield. Geographic features such as elevation and relief also appear on the display. In addition, the PVD map is capable of displaying tactical graphics as shown in the figure. Vehicles located on the terrain being viewed are represented by icons that indicate the position and orientation of the turret. When vehicles move, a trail of dots appear representing previous hull positions. When vehicles fire, fires are depicted as line segments extending from the firing vehicle.

At the bottom of the screen under the map display is a section which identifies the current features of the display. This section provides the coordinates of a selected location, the current icon size, and the current zoom ratio of the display.

The third component of the PVD is the Information Center located in the upper right corner of the screen. This portion of the PVD is used to present information on selected vehicles. This information includes location, speed alignment, ID number, and repair/supply status.

An events section located directly underneath the Information Center provides information on battlefield events. These events include collisions, ground or vehicle impacts, and indirect fire bursts.

Located under the events section, there are several on-screen menus and options that can be selected. These include selections which allow the map to be manipulated (such as zoom or pan), tools that operate on the map display (such as select vehicle or an on-screen ruler which measures distance), and intervisibility options which identify whether there are obstacles which may block visibility between points, vehicles or within an area. Also displayed in this section are options for event flagging and commands for using Data Logger. The interface between event flags and the Data Logger (part of the DIS data collection and analysis system) allows the PVD operator to highlight the occurrence and timing of significant events with event flags. The Data Logger inserts these markers into the data stream to be used as significant, timed event markers for subsequent analysis.

Figure 15. The planned view display

In summary, the PVD provides a "birds eye view" of the battlefield. Terrain, tactical graphics, vehicle movement and firing can all be observed using the PVD and the display tailored to reflect an area of particular interest. The PVD also provides a valuable analysis capability through its real-time event flagging function that yields time stamped significant event markers which are embedded in the data stream and collected using the Data Logger.

Applications. The PVD represents an important tool within the DIS environment for training delivery and feedback. It directly addresses three requirements for improved training which were noted by the Director of Training Developments at Fort Knox in the most recent Armor Conference and were touched upon in our interviews with members of the Army training community. These include needs for: more indepth analyses of tasks, more objective feedback and quality assessment process through After Action Reviews (AARs). In addition to improving the analysis and feedback to soldiers, the PVD also provides a capability for later analysis of training exercises. These analyses offer enormous potential for identifying lessons learned and systemic trends which are observed across multiple exercises and providing more systemic feedback to the Armor community and the Army in general.

Three applications of the PVD that offer strong contributions for improving demonstration, presentation and analysis of training exercises are: real-time exercise monitoring, real-time event flagging and exercise replay. Each of these is discussed below.

The PVD allows the trainer to conduct real-time exercise monitoring without disruption or distraction to soldiers and units participating in the training exercise. Using the PVD, the trainer is able to obtain a "birds-eye view" of the battlefield terrain, to observe the movement and firing of all vehicles on the battlefield, and to zoom in on areas of particular interest. He can also obtain information on specific selected vehicles to better understand their actions. In addition, he can overlay the tactical graphics for the mission comprising the training exercise. This overlay allows the trainer to compare actual battlefield events to planned ones which provides a perspective on mission implementation and accomplishment.

Thus, the trainer can use the PVD to gather observations for immediate exercise control or for later exercise feedback. For example, if Rules of Engagement (ROE) have been established for the exercise, observation using the PVD provides a means for identifying infractions to the ROE and communicating guidance for immediate correction. The trainer also has the opportunity to view the battle from the perspective of his training objectives or other particular concerns on which he wishes to comment later to his unit. In this way, the trainer has a "window" to the battlefield without reducing the realism or interfering with the actions of the training unit.

A second important application of the PVD is real-time event flagging. Using the PVD, significant battlefield events can be flagged as timed markers. These flags are inserted into the automated data stream and can be retrieved for later analysis.

Figure 16 provides an illustration of the event flagging process. As shown, the entities participating in an exercise (in this case, tank simulators and an automated Tactical Operations Center [TOC]) are connected by an Ethernet. Data packets generated by each of these entities are broadcast over the Ethernet and are collected and stored by the Data Logger. Data Logger, a component of the DIS Data Collection and Analysis (DCA) System, is a mass storage device consisting of both hard disk and magnetic tape recording devices. The Data Logger stores packets directly to disk or tape for use in subsequent analysis or replay.

When the PVD is used to mark an event, a flag corresponding to the event is sent as a data packet over the Ethernet. Additional flags mark the start and stop time for the event. In the example shown in Figure 17, the occupation of a battle position was flagged along with start and stop times. The data packets for these flags are broadcast over the Ethernet and collected by the Data Logger for subsequent retrieval or replay.

Users interested in the PVD for event flagging should keep in mind that the PVD records flagged events in the form of timestamped markers. Thus, PVD logs should be developed and maintained during the event flagging process to provide a descriptive recording for each flagged event. These logs also provide secondary advantages by providing prompts or reminders for the PVD operator during the flagging process and serving as a backup record if there is a problem in retrieving the data from Data Logger. An example of a PVD log used to record significant events in a defensive scenario is shown in Table 15.

Once events have been flagged in a training exercise, they can be used in two primary ways. First, the significant event flag can be used to identify the segment of a battle which is to be replayed on the PVD. This replay can provide a focal point of discussion for an AAR or other feedback session. Second, event flags can be retrieved for later analysis. (This capability is currently limited to test-oriented DIS sites such as the Mounted Warfare Test Bed). Retrieval is accomplished using another component of the DCA system, DataProbe, which extracts raw data captured by DataLogger during a training exercise. A third component of the DCA system, RS/1, can then be used to organize the data into files and conduct computations of descriptive statistics or selected inferential statistics. (DataProbe and RS/1 are registered trademarks of BBN Software Products Corporation.)

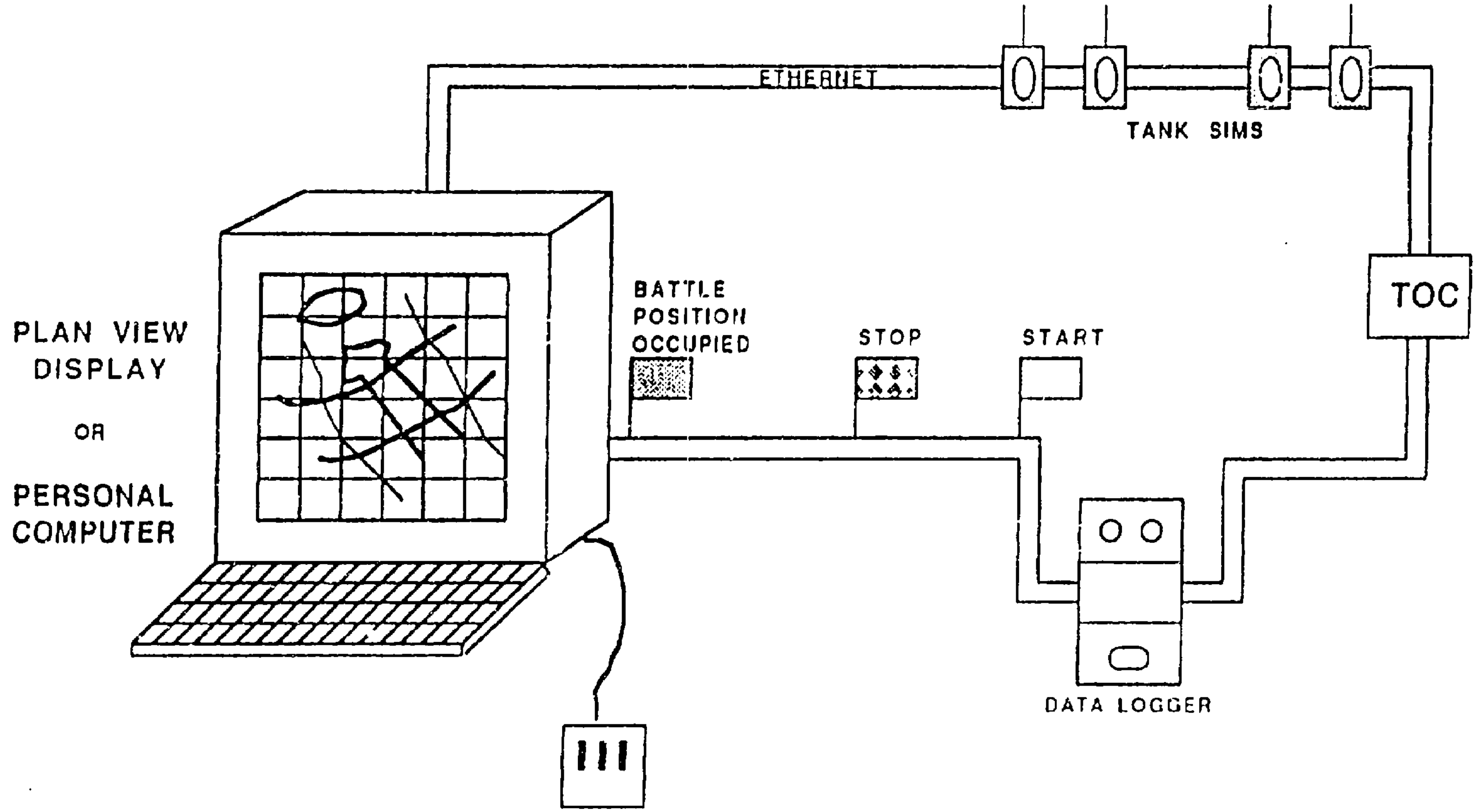


Figure 16. Real time event flagging

Table 15

Example of PVD Log Format

PVD Log - Defensive Scenario

Date:__________

PVD Operator:______________________________

Stage 1

Flag #

_____ Simulation Initiated by REDCON 1 TIME:_____

_____ Bn TOC requests SitRep from Companies [Bn radio net]

Bde Issues INTEL: "ALL SOURCE INTEL REPORTS SIGHTING OF MRR, MOVING ES940650."

OPFOR ARTILLERY BARRAGE ON BPS 10, 20, 30

1-92 MECH BN CDR REPORTS TO BDE CDR HEAVY CONTACT ALONG PL KING

Out of Sector Vehicle(s)

_____ Vehicle(s) goes out of sector Vehicle(s):_____

_____ Vehicle(s) return in sector

What caused vehicle to return in sector (self/other vehicles/ECR)?

Send Flags and Record: Breakdowns (who, what, start, and stop); Halt in Exercise (why, start, and stop); Equipment problems; Anything else noteworthy or out of the ordinary.

____

____

____

____

Analyses of training performance offer strong potential for generating lessons learned or systemic trends of interest to the training community. In addition, if research or evaluation purposes are being served by the exercise, the use of such automated data offers considerable savings in manual data coding time and

increased accuracy, especially for time-based measures typically collected using "stop watch" methods.

Finally, the PVD may be used as a vehicle for exercise replay. This replay may serve a variety of purposes such as demonstrations of key teaching points or feedback to a training unit. The segment for replay may be defined using a significant event flag as described above or a specific time point. This replay allows viewers to observe the progress of the battle including vehicle movement and firing activity. Action can be stopped as discussion ensues or moved backward or forward. Furthermore, tools embedded in the PVD can be used to demonstrate a point or stimulate discussion. For example, the intervisibility function provides a means for examining how vehicles use terrain to their advantage (or not).

In summary, the above applications illustrate how the PVD can be used to strengthen demonstration, presentation and analysis. Training exercises can be monitored, significant events flagged, and replay(s) conducted to illustrate a key teaching point or stimulate discussion among training participants. Significant events can also be collected and analyzed after the training exercise to identify important performance trends.

A final comment on applications of the PVD is warranted. While the main focus of this discussion is on tools for demonstration, presentation and analysis, it should be noted that the PVD also provides a useful tool in the planning process for training exercises, specifically, training scenario development.

Developing scenarios for use in training is generally a time consuming process. The PVD provides an overlay menu which can be used to develop tactical overlays for use in training exercises. Overlays can be created using the overlay menu which contains unit symbols, free draw objects and control points. These tools allow the user to build a tactical overlay which places units in desired positions, identifies phase lines, boundaries and battle positions, and identifies up to six kinds of control points (including check, contact, release/start, coordinating, linkup and passage points). Once an overlay has been developed and edited to the user's satisfaction, it can be saved for later use. This capability is important for structuring exercises within the DIS environment and allows trainers to establish a library of exercise scenarios which they can call upon for various training purposes.

Resources. Interested users of the PVD should consult the User Guide. It provides specific operational instructions and documents the capabilities of the PVD:

Bolt, Beranek & Newman, Inc. (1991b). SIMNET Plan View Display user manual (Report No. 7618). Cambridge. MA: BBN Systems and Technologies, Inc.

Stealth

The Stealth vehicle allows an observer to travel anywhere on the DIS battlefield undetected by other vehicles. Using the various modes of travel available with the Stealth, an observer can obtain a three dimensional view of the battlefield from the ground, water or air. Thus, the Stealth provides a valuable tool for real time observation of an exercise and later replay for demonstration of a key teaching point or discussion in an After Action Review (AAR). In addition, the Stealth provides a valuable tool for training leaders to perform reconnaissance missions since participants can realistically traverse the battlefield as they would in a ground vehicle.

Capsule Description. The Stealth consists of three video monitors which provide the operator a panoramic view of the battlefield. The Stealth terminal also includes a Plan View Display (PVD) which provides a two-dimensional, "bird's eye view" of the battlefield (see previous section). The operator controls the Stealth using a joystick-type device called a Spaceball and an electroluminescent flatpanel with a touchscreen.

The Stealth is able to travel over the battlefield without being seen or affecting events taking place on the battlefield. It can be used to easily observe any battlefield event with capabilities to traverse ground, water and air. This observation can be made in real time during a training exercise or during a replay afterwards. In the replay mode, the Stealth can travel forward and backward in time by fast forwarding or rewinding the recording. It can also jump to a specific point in time designated by hours, minutes and seconds into the battle.

The Stealth vehicle has four major modes of travel. The first is free fly. Free fly is the most basic of flight modes and is the mode in which the Stealth appears when first initialized. Free fly allows the operator to travel over the simulated terrain unimpeded in three dimensions. In this mode, the Stealth vehicle can move forward or backward parallel to flat and level ground, to the right or left, up or down in altitude, spin around, and pitch its viewpoint up or down. The free fly mode is unaffected by the ground and the Stealth can travel up to 575 knots or about 1,060 kph in any direction.

The second mode in which the Stealth can travel is the terrain hug mode. This mode is similar to free fly except that the operator has no control of his up and down direction. The altitude of the Stealth is fixed at 2.6 meters above ground level, the height of the M1 commander's hatch. This fixing of altitude allows the Stealth Vehicle operator to drive along the terrain as if in a ground vehicle. Maximum speed for the terrain hug mode is 86 knots or about 160 kph.

A third mode of Stealth travel is teleporting. In this mode, the operator can instantly transport the Stealth to a specific location on the battlefield. When teleported, the Stealth vehicle faces in the desired direction at the specified location and is located parallel to flat ground.

A fourth Stealth mode of travel is attaching to vehicles. In this mode, the Stealth Vehicle may be flown by latching or attaching to another vehicle. This mode allows the operator to follow vehicles with no effort, freeing his attention to concentrate on battlefield events.

There are four different ways to attach to a vehicle. They first way is the tether mode. In this mode, the Stealth Vehicle is linked to the speed and heading of a target vehicle. Thus, if the target vehicle moves, the Stealth moves with the same velocity. Similarly, if the target vehicle changes its heading (for example, a helicopter executing a tail spin), the Stealth will follow (for example, the Stealth would follow the spin of the helicopter as if attached on the end of a tether). The initial position for the tether mode is 70 meters directly behind the target vehicle and 5 meters above it. This mode is useful for observing a vehicle and its activities on the simulated battlefield with respect to some particular aspect of its orientation. For example, an observer might be interested in how a tank commander reacts to situations in front of his tank.

Another mode of attaching to a vehicle is the orbit mode. In this mode, the Stealth always points at the target vehicle and navigates around it in a sphere. The operator can adjust the size of the orbiting sphere and move closer (but no closer than 10 meters) or farther away (but no farther than 300 meters) from the target vehicle. The Orbit mode provides a mechanism for focusing attention on the target vehicle and its actions. It also provides an easy way to navigate around the vehicle to assess the situation on different relative headings.

A third way to attach to a vehicle is the compass mode. In this mode, the Stealth is attached to a target vehicle and moves the same speed; however, the Stealth maintains a specific compass heading. Thus, even if the target vehicle turns, the Stealth does not change its compass heading. So, for example, if the Stealth is facing North and attached to the rear of a tank traveling Northward, the Stealth follows at the same speed. However, if the tank makes a 180 degree turn and begins to drive south, the Stealth continues to face North and is pushed backward at the same speed. This mode was developed for observing a battle that the target vehicle is participating in rather than focusing on the vehicle itself. It allows the Stealth observer to watch moves that the vehicle makes as well as watch other battle events.

A final way of attaching to a vehicle is the mimic mode. In this mode, the Stealth becomes embedded within the carget vehicle

and inherits all its components of speed and orientation. When the mimic mode is established, the Stealth vehicle view coincides with the front and center view of the target vehicle. For an M1 tank, this view corresponds roughly to the open hatch view of a tank commander. This mode is useful if an observer wishes to understand the crew's view of the situation and analyze their responses. In the mimic mode, it is also possible for the Stealth to mimic the gunner's view. When the Stealth is attached to a vehicle with a turret and a gun, the Stealth operator is able to call up the view out the gunner's channel. This view is provided at a ten power magnification regardless of the actual magnification of the target vehicle's gunsight. The gunner's mimic mode is useful for understanding the perspective of the gunner and analyzing his actions.

When the Operator initializes the Stealth vehicle, it is brought up in free fly mode with a heading of North. The Stealth provides a compass reading in the form of a round compass. The operator may change modes of travel as desired depending on his purposes. When he has attached the Stealth to a target vehicle, the Stealth display also provides the vehicle identifier of that vehicle.

In summary, the Stealth provides a "window" onto the battlefield. It allows an observer to enter the battlefield undetected and to observe all events taking place without influencing them in any way. The Stealth can travel in different modes which provide various perspectives depending on the objectives of the observer.

Applications. The Stealth offers a unique capability for observing the battlefield without influencing or disrupting events in any way. From a training perspective, it offers a flexible tool for real time observations and demonstrations and a realistic source of information for AARs. The need for quality AARs and objective feedback was mentioned repeatedly in our interviews on training requirements with the Army training community. In addition, the Stealth provides a method for training planning and preparation skills on the battlefield, such as leader reconnaissance. For example, the Mission Training Plan for the Tank and Mechanized Infantry Battalion Task Force, ARTEP 71-2-MTP (Department of the Army, 1988b), identifies accomplishment of reconnaissance as a critical task in the command and control of the battalion task force. The battalion commander, subordinate leaders and staff are directed to conduct a personal reconnaissance whenever possible as part of this task.

Thus, there are at least three applications of the Stealth that substantially improve Army capabilities for the demonstration, presentation and analysis of training exercises. They include: real-time exercise observation, exercise playback to support AARs, and training planning and preparation tasks such as leader reconnaissance. Each of these are discussed below.

The Stealth provides an opportunity for the trainer or other personnel to experience the battle from the perspective of those engaged in the action. This real-time observation is a powerful tool for monitoring the battle and demonstrating to interested parties the power of DIS for training. For example, observers can free fly over the entire battlefield to gain an understanding of the "big picture." They can also attach themselves in the tethering mode, for example, to a particular vehicle such as the battalion commander and experience the battle from his perspective. Not only does such observation yield insights into the relationships between the view from a vehicle and actions taken for later discussion, but it also provides a strong demonstration on the realism and value of DIS as a technology to support training.

The Stealth also provides a significant improvement in realistic replay for training feedback purposes such as AARs over other available replay technologies. Using the Stealth, a battle can not only be replayed but it can be reexperienced. The different modes of travel that are possible with Stealth provide the AAR leader with a persuasive toolkit for stimulating discussion and illustrating key teaching points. Members of the training unit can be teleported to a key turning point in the battle using Stealth and allowed to relive the moment. Using the mimic mode, they can reexperience the battle from the perspective of a target vehicle, such as the commander of an overrun company. As the discussion warrants, the battle can be backed up in time or taken forward in time using the Stealth. This flexible and realistic approach to reexperiencing a battle provides a wealth of information for the AAR. Furthermore, it provides soldiers with an experience-based understanding of key teaching points. This hands-on approach to training feedback far surpasses more conventional discussion techniques in contributing to an in-depth understanding of unit performance.

Finally, the Stealth is also a natural vehicle for training planning skills, such as leader reconnaissance. For example, ARI-Knox has used the Stealth to structure a leader reconnaissance exercise at the battalion level. The exercise includes a battalion commander, his staff, and his company commanders. The leaders reconnaissance uses the Stealth to emulate the route and view of a vehicle traveling along the forward-most phase line of the battle area. Thus, the leaders reconnaissance allows a ground view of the area between unit battle positions and their engagement areas.

In conducting the leaders reconnaissance using Stealth, the battalion commander, his S3 and S2, and his company commanders accompany the battalion Executive Officer (XO) to the Stealth terminal after the brigade and battalion operations orders have been issued. For the purposes of the exercise, the entire command group participates in the leaders reconnaissance using the single Stealth vehicle. While its is recognized that an entire command

group would never participate in a leader's reconnaissance by using a single vehicle on the actual battlefield, this joint participation on the simulated battlefield has training value.

More specifically, the leader reconnaissance exercise using the Stealth begins by the battalion XO orienting all personnel to the location of the start point and the scheduled route of travel. Prior to beginning movement, the XO provides a 360 degree sweep of the terrain from the start point using the Stealth controls. The Stealth then proceeds down its route tethered to a target vehicle. (This attachment frees personnel conducting the reconnaissance from ground driving.) Along the route, the XO keeps the Stealth view in the general direction of the enemy but responds to orders for different view directions from the battalion commander or S3. During this process, the XO must verbally comment on terrain orientation (such as company boundaries) and the S2 must be prepared to answer questions about the terrain such as likely enemy avenues of approach. At a specified checkpoint on the route, the reconnaissance vehicle stops and completes another 360 degree view of the terrain. This process continues until the Stealth reaches the release point for the route. To enhance realism, incoming artillery is generated by the SAFOR-operator to force the hasty withdrawal of the reconnaissance vehicle and the return of the commander, his staff and subordinate commanders to the TOC area.

This ARI-Knox developed exercise provides a realistic strategy for training leader reconnaissance skills and for members of the battalion to work together in performing their individual responsibilities in the course of conducting a reconnaissance. It provides a strong demonstration of the capabilities of the Stealth for such training purposes.

In summary, the Stealth provides a valuable tool for observing a training exercise, providing a replayed experience to stimulate discussion and training feedback and training planning skills such as leaders reconnaissance. The Stealth capability to insert yourself invisibly onto the battlefield and to travel in a variety of modes depending on your interests and desired perspective is an extraordinarily useful tool which will no doubt expand in its applications as the use of DIS-based training grows.

Resources. The primary documentation for the Stealth is a report describing the functional specifications of the Stealth Vehicle and providing directions to the operator. This document is generally available in DIS facilities:

Katz, W.J. (1990). SIMNET Stealth vehicle functional specification and operator's manual. Cambridge, MA: BBN Systems and Technologies, Inc.

Mini Cameras

ARI-Knox has introduced mini cameras into the DIS environment to capture video recordings of soldiers participating in tactical exercises. The mini cameras offer potential for real time observation and monitoring during a training exercise, particularly in closed simulators, and a rich performance record for subsequent analysis.

Capsule Description. Mini cameras are very small (approximately 3 inches in length) devices which can be unobtrusively mounted to record performance at an operator station. ARI-Knox has used Panasonic VHS mini cameras, although comparable products can be acquired from other manufacturers.

Mini cameras can be placed in a variety of locations depending on information needs. For example, they can be mounted to capture manipulations of a device or states of a workstation display. Audic can be captured from radio nets to accompany the video recordings.

The utility of the mini cameras is enhanced by a family of supporting equipment. The equipment acquired by ARI-Knox for this purpose includes: two VCR recorders for making audiovisual recordings, a Color Quad System providing a quadraplexing capability for recording four wide tracks on a single VCR tape, and a Date/Time Display Generator for timestamping video recordings. The latter capability allows video recordings to be cross-referenced with data collected from the automated data stream in the DIS environment. If users wish to record images on a workstation display directly onto videotape, a direct link can be established. This interface can be accomplished by using a video scan converter (such as the RGB/Videlink 1600U) to convert workstation screen states to National Television System Committee (NTSC) video format.

Applications. The use of mini cameras offers advantages for both training delivery and feedback in the DIS environment. As does the PVD, the use of mini cameras directly addresses three requirements for improved training which were noted by the Director of Training Developments at Fort Knox in the most recent Armor Conference and were touched upon in our interviews with members of the Army training community. These include needs for: more indepth analyses of tasks, more objective feedback and quality assessment through After Action Reviews (AARs). In addition to improving the analysis and feedback to trainees, mini cameras also provide a capability for later analysis of training performance. While analysis of videotapes is timeconsuming, such analyses do offer enormous potential for identifying lessons learned and systemic trends which are observed across multiple exercises and for providing more systemic feedback to the Armor community.

There are three primary training applications for mini cameras in the DIS environment. They include using mini cameras: (a) to monitor real-time training performance; (b) to capture video footage for preparation of a demonstration tape; and (c) to capture performance for subsequent in-depth analysis. Each are discussed below.

First, mini cameras can provide a valuable tool for <u>monitoring training performance during real time</u>. Since mini cameras are small and unobtrusive, they provide a mechanism for viewing the behavior of participants in a training exercise which may be less disruptive and distracting than if a human observer were physically present. Furthermore, in a closed simulator, mini cameras provide a "window" that would otherwise be unavailable. This real time observation can serve a number of purposes. For example, it provides a mechanism for exercise control since the trainer can observe individual performance and make real time correction, if necessary, to retain the integrity of the exercise. Furthermore, the trainer may identify segments of selected video recordings which he may wish to replay during an AAR or other type of feedback session to demonstrate or generate discussion relative to a particular teaching point. Segments from a videotape stream also provide a contextual background for other discussion points and convey complex behaviors with more clarity and objectivity than might be possible using other means of description.

Mini cameras also offer a tool for capturing video footage which can be used in the <u>preparation of a demonstration tape</u>. Successful training in a DIS facility requires that soldiers can competently use the simulation equipment. Furthermore, as new devices are fielded and incorporated into the DIS environment for training, training requirements to operate the equipment become paramount. Demonstrations using videotape are widely recognized as a productive approach for introducing complex skills--an approach that has been used with success by ARI. Mini cameras provide a means for capturing operator performance and preparing a demonstration tape to introduce soldiers to the new equipment and how to operate it. This demonstration can then be followed by hands-on training which is more productive than had soldiers moved from an introductory briefing directly to equipment operation.

Finally, mini cameras allow <u>performance of trainees to be captured for subsequent in-depth analysis</u>. In-depth analysis of soldier performance is becoming increasingly recognized as vital for designing and improving training exercises. For example, indepth analysis of the performance of an operator on a new piece of equipment provides valuable insights into the training requirements associated with that piece of equipment. In addition, examining performance over many training exercises provides a basis for identifying areas where performance requires strengthening and training exercises require improvement.

From a data capture perspective, using mini cameras to acquire video footage for later analysis offers several advantages. First, it reduces the manpower requirements compared to manual data collection. Second, it provides a record of complex behaviors which may require assessment by more than one subject matter expert (SME) who may not necessarily be available during a training exercise. Finally, video recordings also allow for more than one observer of a given behavior and the opportunity to assess the consistency of observations among observers (i.e., inter-rater reliability). The latter advantage provides a firm foundation for establishing the technical integrity of the data than might otherwise be possible.

However, it should be noted that there are disadvantages and costs incurred in using videotape analysis. Probably most challenging is devising a scheme for characterizing behavioral observations (that is, deciding what to measure and how to measure it). This process involves developing well-defined behavioral categories, formulating a specific measure of the behavior, determining the criteria for deciding whether a behavior falls in a particular category, and deciding whether all occurrences of a behavior will be recorded or a sampling strategy invoked. Once the content and format for the measurement have been resolved, it is desirable to establish the reliability of these measures. Also challenging is the manpower required to undertake videotape coding. This is a time consuming process which should not be underestimated.

In summary, mini cameras can serve as a useful tool for strengthening demonstration, presentation and analysis in the DIS environment. Video recordings offer the potential for more in-depth analyses of tasks and behavior, more objective feedback and a pictorial medium for incorporation into an AAR. However, it should be noted that, while video capture offers personnel savings in the collection phase, it levies considerable personnel requirements for later analysis.

Resources. Users interested in using mini cameras may wish to consult:

Operating instructions for Panasonic Industrial Color CCD GP-K2102.

Summary

This Research Product has presented training tools developed for use within the DIS environment. The document is intended to serve as a catalog of reference information for users and planners of DIS facilities.

Table 16 presents a summary overview of the three categories of training tools presented: (a) techniques for structuring simulation-based exercises; (b) strategies for eliciting and capturing C3 performance; and (c) approaches for demonstration, presentation, and analysis. The table highlights the specific training requirements addressed by the application of each tool and the types of training objectives and purposes which are appropriate.

Table 16

Summary of Training Applications

TECHNIQUES FOR STRUCTURING SIMULATION-BASED EXERCISES		
Tool	**Training Requirements**	**Training Objectives/Purposes**
Tactical Vignettes	Standardized Training Iterative Training Objective Feedback	STXs Selected ARTEP Training Tasks - crew skills, teamwork, reporting a navigation Emerging Training Tasks Managing incoming information appropriately Using voice and digital communications effectively
Tethering/Automated Messaging	Standardized Training Hands-On Training Cross Training Multiple Training Situations Greater Training Realism	Use horizontal slice to focus on C3 at specific command level Use vertical slice to focus on C3 interactions up and down chain of command Focused message for C3 skills, information management tasks
Checkpointing	Greater Frequency of Training Exercises More Iterations Focused on Specific Tasks	Information management skills Fundamental C3 skills Operation as an Integrated Bn staff
STRATEGIES FOR ELICITING AND CAPTURING C3 PERFORMANCE		
Instrumented Devices	Greater Emphasis on Simulation-Based Training Use of "Plug-In" C3 Devices Objective Feedback Training Using Automated C3 Devices	rator Training of C3 vices Integrated Usage in Tactical Environment

Table 14

Summary of Training Applications (Concluded)

SEND	Improved Training Efficiency Increased Standardization	Information Management Skills for TOC Operation
LISTEN	Real time Message Monitoring More Objective Training Feedback	Information Management Skills
Control Measure Performance Measurement System	Objective Feedback	C3 to Ensure Adherence of Unit Maneuver to Control Measures
APPROACHES FOR DEMONSTRATION, PRESENTATION AND ANALYSIS		
Tool	Training Requirements	Training Objectives/Purposes
Plan View Display	In-Depth Task Analyses More Objective Feedback Quality Assessment Process	Real-time Exercise Monitoring Real-time Event Flagging Exercise Replay
Stealth	Quality AARs Objective Feedback	Real-time exercise Observation Exercise Playback to Support AARs Training planning and preparation tasks (e.g., leader reconnaissance)
Mini-Cameras	In-Depth Task Analyses More Objective Feedback Quality Assessment Process	Real-time monitoring of training performance Preparation of a Demonstration Tape Performance Capture for Subsequent in-depth analysis

References[1]

Ainslie, F.M., Leibrecht, B.C. & Atwood, N.K. (1991). Combat vehicle command and control systems: III. Simulation-based company evaluation of the soldier machine interface (SMI) (ARI Technical Report 944). Alexandria, VA: U.S. Army Research Institute for the Social and Behavioral Sciences.

Alluisi, E.A. (1991). The development of technology for collective training: SIMNET, a case history. Human Factors, 33, 343-362.

Atwood, N.K., Quinkert, K.A., Campbell, M.R., Lameier, K.F., Leibrecht, B.C., & Doherty, W.J. (1991). Combat vehicle command and control systems: IV. Training implications based on company level simulation (ARI Technical Report 943). Alexandria, VA: U.S. Army Research Institute for the Social and Behavioral Sciences.

Beaver, R., Brasch, R., Burdick, C., Butler, B., Downes-Martin, S., Eller, T., Ferguson, B., Gotuby, D., Huber, J., Katz, W., Miler, B., Morrison, J., Sherman, R., Stanley, W. & Yelowitz, K. (1992). Strawman Distributed Interactive Simulation architecture description document, Volume 1: Summary description. Orlando, FL: Loral Systems Company.

Bolt, Beranek & Newman, Inc. (1991a). SIMNET CVCC Battalion Tactical Operations Center (Bn TOC) Workstation User Manual. (Release 1.5, Report No. 7629). Cambridge, MA: BBN Systems and Technologies Corporation.

Bolt, Beranek & Newman, Inc. (1991b). SIMNET Plan View Display User Manual. (Report No. 7618). Cambridge, MA: BBN Systems and Technologies, Inc.

Bolt, Beranek & Newman, Inc. (1992). CVCC Utilities User Manual. Cambridge, MA: BBN Systems and Technologies.

Department of the Army (1988a). Training the force (Field Manual 25-100). Washington D.C.: Author.

Department of the Army (1988b). Mission training plan for the tank and mechanized infantry battalion task force (ARTEP 71-2-MTP). Washington D.C.: Fort Benning, GA: U.S. Army Infantry School.

[1]Unpublished references may be obtained by contacting the authors and/or the preparing agency. Published references may be obtained through the Defense Technical Information Center (DTIC).

Department of the Army (1988c). Mission training plan for the tank and mechanized infantry company and company team (ARTEP 71-1-MTP). Washington D.C.: Fort Knox, KY: U.S. Army Armor School.

Department of the Army (1988d). Mission training plan for the tank platoon (ARTEP 17-237-10-MTP). Washington D.C.: Author.

Department of the Army (1991a). The battle-focused Combined Arms Training Strategy (CATS): Armor (Training Circular, Coordinating Draft, No. 17-12-7). Washington D.C.: Author.

Department of the Army (1991b). A concept for AirLand operations for a strategic army (Draft TRADOC Pamphlet 525-5B). Washington D.C.: Author.

DuBois, R.S. & Smith, P.G. (1989). Simulation-based evaluation of a position navigation system for armor: Soldier performance, training, and functional requirements (ARI Technical Report 834). Alexandria, VA: U.S. Army Research Institute for the Social and Behavioral Sciences.

DuBois, R.S. & Smith, P.G. (1991). Simulation-based assessment of automated command, control, and communication for armor crews and platoons: The intervehicular information system (IVIS) (ARI Technical Report 918). Alexandria, VA: U.S. Army Research Institute for the Social and Behavioral Sciences.

Garvey, R.E., Radgowski, T. & Heiden, C.K. (1988). SIMNET-D standing operating procedure. (Report No. 6929). Cambridge, MA: BBN Systems and Technologies Corporation.

General Accounting Office (1991). Army training: Various factors create uncertainty about need for more land (GAO/NSIAD-91-103). Washington D.C.: General Accounting Office.

Henderson, J. (1992). IVIS operational concept. Fort Knox, KY: U.S. Army Armor Center.

Katz, W.J. (1990). SIMNET Stealth vehicle functional specification and operator's manual. Cambridge, MA: BBN Systems & Technologies, Inc.

Leibrecht, B.C., Kerins, J.W., Ainslie, F.M., Sawyer, A.R., Childs, J.M., & Doherty, W.J. (1992). Combat vehicle command and control systems: I. Simulation-based company level evaluation (ARI Technical Report). Alexandria, VA: U.S. Army Research Institute for the Social and Behavioral Sciences.

Lickteig, C. (1992). Prototype methods for training and assessing future tactical command and control skills (ARI Research Product). Alexandria, VA: U.S. Army Research Institute for the Social and Behavioral Sciences.

Meliza, L.L., Bessemer, D.W., Burnside, B.L., and Shlechter, T.M. (1992). Platoon-level after action review aids in the SIMNET Unit Perforamnce Assessment System (ARI Technical Report 956). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Services.

O'Brien, L.H., Leibrecht, B.C., Ainslie, F.H., Williams, G.S., & Smart, D.L. (1991). Research plan for the combat vehicle command and control battalion-level formative evaluation, Volume 3 (ARI Technical Report). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Quinkert, K.A. (1990). Crew performance associated with the simulation of the Commander's Independent Thermal Viewer (CITV) (ARI Technical Report 900). Alexandria, VA: U.S. Army Research Institute for the Social and Behavioral Sciences.

Radgowski, T. & Garvey, R.E. (undated). SIMNET-D: Combat modeling through interactive simulation. Cambridge, MA: BBN Systems and Technologies Corporation.

Saffi, M.R. (1991). SIMNET-Automated Forces: The combined arms workstation user's guide (Report No. 7025). Cambridge, MA: BBN Systems and Technologies Corporation.

U.S. Army Armor Center (1990) Armor 2000: A balanced force for the Army of the future. Fort Knox, KY: Author.

Winsch, B.J., Atwood, N.K., Sawyer, A.S., Quinkert, K.A., Heiden, C.K., Smith, P.G. and Schwartz, B.(in preparation). Innovative training concepts for use in Distributed Interactive Simulation (DIS) environments (ARI Research Product). Alexandria, VA: U.S. Army Research Institute for the Social and Behavioral Sciences.

Appendix A

Interview Protocol Used at Fort Knox

As part of ARI-Knox's research efforts concerning training requirements for future tank technologies, we are conducting interviews with selected experts on Armor training. You have been requested for this interview because of the depth and breadth of your experience and expertise in the Armor community. While we realize that network simulation was not a capability when current training was developed, we are now interested in using your expertise to identify ways that network simulation can be used to enhance training. We want to draw upon field experience and any knowledge of network simulation, particularly CCTB (SIMNET-D) or CATTC (SIMNET-T) experience.

The focus of the questions will be on HIGH PRIORITY TRAINING NEEDS in the Armor community and the use of network simulation. WE have organized our questions into two parts: the first dealing with current training needs and the second with emerging or future training needs.

INTERVIEWER'S PROTOCOL GUIDE

GENERAL GUIDELINES

(1) Draw upon field experience and any knowledge of network simulation, particularly CCTB (SIMNET-D) or CATTC (SIMNET-T) experience.

(2) Focus on the interactions among the following positions: **Tank Commander, Platoon Leader, Company Commander, XO, S2, S3, and Battalion Commander.**

(3) Refer to the Command and Control, Intelligence, and Maneuver BOSs. Focus on specific performance deficiencies and the evidence underlying this assessment.

POTENTIAL PROBES (choose questions appropriate to respondent's level of knowledge of network simulation and CVCC):

Task level information

1. Describe specific tasks/functions that relate to this issue. What is the criticality of each task? What are some specific problems encountered with each task?

2. How might network simulation be used to solve these problems?

Positional information

1. What specific positions (i.e., TC, PLT LDR, Co Cdr, XO, S2, S3, and Bn Cdr) will be most impacted by automated C3 equipment? How will the training requirements of these positions differ as new C3 equipment is introduced?

2. How might network simulation be used to address these requirements?

Army Training System

1. How would you go about incorporating the new training requirements you have suggested into the Army's larger training system?

Projected Combat Requirements

1. What tasks will be impacted by projected changes in the threat or battlefield environment? How will this influence tactics, techniques, or procedures? How will training requirements vary by position? How can network simulation be used to facilitate training of these tasks?

2. What tasks will be impacted by future shifts in unit missions? How will training requirements vary by position? How can network simulation be used to facilitate training of these tasks?

RESPONSE GUIDE FOR
ARMOR TRAINING SUBJECT MATTER EXPERTS

GENERAL RESPONSE GUIDELINES

(1) Draw upon field experience and any knowledge of network simulation, particularly CCTB (SIMNET-D) or CATTC (SIMNET-T) experience.

(2) Focus on the interactions among the following positions: **Tank Commander, Platoon Leader, Company Commander, XO, S2, S3, and Battalion Commander.**

(3) Refer to the Command and Control, Intelligence, and Maneuver BOSs. Focus on specific performance deficiencies and the evidence underlying this assessment.

For each question, please refer to the general response guidelines and the appropriate BOS.

CURRENT Training Needs

1. How can network simulation be used to enhance current training on **Command and Control** tasks currently prescribed by doctrine? How will training requirements vary by position?

COMMAND AND CONTROL BOS

<u>Acquire and Communicate Information and Maintain Status</u>
Communicate Information
.Receive and Transmit Mission
.Receive and Transmit Enemy Information
.Receive and Transmit Terrain and Weather Information
.Receive and Transmit Friendly Information
Manage Means of Communicating Information (e.g., written, voice, digital)
Maintain Information and Force Status
.Store Information
.Display Information
.Publish and Reproduce Information
.Manage Information Distribution
<u>Assess Situation</u>
Review Current Situation
.Analyze Mission
.Fuse Information
.Evaluate Incoming Information
Project Future Requirements
Decide on Need for Action or Change
<u>Determine Actions</u>
Issue Planning Guidance
Develop Courses of Action
Analyze Courses of Action
Compare Courses of Action
Select or Modify Courses of Action
<u>Direct and Lead Subordinate Forces</u>
Prepare Plans or Orders
.Develop and Complete Plans or Orders
.Coordinate Support
.Approve Orders
Issue Orders
Provide Command Presence
Maintain Unit Discipline
Synchronize Tactical Operations
<u>Employ Tactical C^3CM</u>

CURRENT Training Needs

2. How can network simulation be used to enhance training on **Intelligence** tasks currently prescribed by doctrine? How will training requirements vary by position?

INTELLIGENCE BOS

Collect Information
Collect Information on Situation
.Collect Threat Information
.Collect Physical Environment Information
.Collect Information on Social/Political/Economic Environment
Collect Target Information
.Search for Targets
.Detect Targets
.Locate Targets
.Identify Targets
.Conduct Post-Attack Target Damage Assessment
Process Information
Evaluate Threat Information
.Review Holdings
.Consider Enemy Doctrine
Evaluate Physical Environment Information
.Review Holdings
.Consider Status
.Develop Impacts
Evaluate Social/Political/Economic Environment
Integrate Intelligence Information
.Develop Enemy Intentions
.Develop Targeting Information
Prepare Intelligence Reports
Prepare Reports on Target Development
Prepare Reports on Enemy Intentions
Prepare Reports on the Battlefield Area
Prepare Reports on Enemy Situation

CURRENT Training Needs

3. How can network simulation be used to enhance current training on **Maneuver** tasks currently prescribed by doctrine? How will training requirements vary by position?

MANEUVER BOS

Move
Position/Reposition Forces (Units and Equipment)
.Prepare for Movement
.Move On or Under Surface
.Move While Mounted
.Move While Dismounted
.Move Through Air
.Close into Tactical Position
Negotiate Terrain
Navigate
Engage Enemy
Employ Direct Fire
.Process Direct Fire Targets
.Select Direct Fire Targets
.Select Direct Fire System
.Engage Direct Fire Targets
Conduct Close Combat
Integrate Direct Fire with Maneuver
Control Terrain
Control Terrain through Fire or Fire Potential
Occupy Terrain

EMERGING Training Requirements

1. How will the acquisition of new devices, especially C3 devices (e.g., POSNAV, IVIS, CITV), impact training requirements for **Command and Control** tasks? How will these requirements vary by position?

COMMAND AND CONTROL BOS

Acquire and Communicate Information and Maintain Status
Communicate Information
.Receive and Transmit Mission
.Receive and Transmit Enemy Information
.Receive and Transmit Terrain and Weather Information
.Receive and Transmit Friendly Information
Manage Means of Communicating Information (e.g., written, voice, digital)
Maintain Information and Force Status
.Store Information
.Display Information
.Publish and Reproduce Information
.Manage Information Distribution
Assess Situation
Review Current Situation
.Analyze Mission
.Fuse Information
.Evaluate Incoming Information
Project Future Requirements
Decide on Need for Action or Change
Determine Actions
Issue Planning Guidance
Develop Courses of Action
Analyze Courses of Action
Compare Courses of Action
Select or Modify Courses of Action
Direct and Lead Subordinate Forces
Prepare Plans or Orders
.Develop and Complete Plans or Orders
.Coordinate Support
.Approve Orders
Issue Orders
Provide Command Presence
Maintain Unit Discipline
Synchronize Tactical Operations
Employ Tactical C^3CM

EMERGING Training Requirements

2. How will the acquisition of new devices, especially automated C3 devices (e.g., POSNAV, IVIS, CITV), impact training requirements for **Intelligence** tasks? How will these requirements vary by position?

INTELLIGENCE BOS

Collect Information
Collect Information on Situation
.Collect Threat Information
.Collect Physical Environment Information
.Collect Information on Social/Political/Economic Environment
Collect Target Information
.Search for Targets
.Detect Targets
.Locate Targets
.Identify Targets
.Conduct Post-Attack Target Damage Assessment
Process Information
Evaluate Threat Information
.Review Holdings
.Consider Enemy Doctrine
Evaluate Physical Environment Information
.Review Holdings
.Consider Status
.Develop Impacts
Evaluate Social/Political/Economic Environment
Integrate Intelligence Information
.Develop Enemy Intentions
.Develop Targeting Information
Prepare Intelligence Reports
Prepare Reports on Target Development
Prepare Reports on Enemy Intentions
Prepare Reports on the Battlefield Area
Prepare Reports on Enemy Situation

EMERGING Training Requirements

3. How will the acquisition of new devices, especially automated C3 devices (e.g., POSNAV, IVIS, CITV), impact training requirements for **Maneuver** tasks? How will these requirements vary by position?

MANEUVER BOS

Move
Position/Reposition Forces (Units and Equipment)
.Prepare for Movement
.Move On or Under Surface
.Move While Mounted
.Move While Dismounted
.Move Through Air
.Close into Tactical Position
Negotiate Terrain
Navigate
Engage Enemy
Employ Direct Fire
.Process Direct Fire Targets
.Select Direct Fire Targets
.Select Direct Fire System
.Engage Direct Fire Targets
Conduct Close Combat
Integrate Direct Fire with Maneuver
Control Terrain
Control Terrain through Fire or Fire Potential
Occupy Terrain

EMERGING Training Requirements

4. What training requirements do you anticipate emerging from the potential information load provided by automated equipment? How will these requirements vary by position?

INNOVATIVE Training

1. Imagine that you have been tasked with training soldiers to use the automated report function of a new device. This functionality allows the user to send and edit overlays and FRAGOs. To assist with the training, you have just procured one piece of equipment that allows you to vary the number and time interval of reports (including overlays and FRAGOS) sent to trainees. A second piece of equipment allows you to capture each trainee's "reply". How would you utilize this equipment for command and control training?

2. Imagine that you have been tasked with training soldiers to selectively attend to digital reports (e.g., Contact, Call for Fire, Situation) in the report queue of a new piece of equipment. What design features would you recommend including with this equipment to assist soldiers in training?

ADDITIONAL Comments

1. We would appreciate any other comments that would help us understand the high priority areas of training needs or future training requirements within the Armor community that may be related to network simulation and command and control issues.

2. Can you recommend any documents or other supporting materials which we might obtain on this topic?

Appendix B
Interview Protocol Used at Fort Leavenworth

General Purpose Statement:

We are currently engaged in conducting research on innovative strategies for training command and control skills of Armor officers at Battalion and below. We are particularly interested in the impact of emerging automated command and control devices on training requirements and the potential contributions that simulation networking can make to training in this area.

We are interested in your perspective based on your past experience and your current assignment. More specifically, we are interested in your views on emerging training requirements for command and control, particularly as automated devices become fielded, and how these requirements might be addressed in innovative ways using simulation networking. We are also interested in seeing a demonstration of any innovative approaches here at Leavenworth which you feel may illustrate some productive strategies in this area.

We'd like to start with a few specific questions. Then we'd like to get any general comments or observations that you may have.

Combined Arms Training Integration Division:

(1) What new types of command and control skills will be required as the Combined Arms Training Strategy (CATS) becomes implemented?

- oo Probe for echelon (Battalion and below)
- oo Probe for position (e.g., Battalion Commander)

(2) How will command and control requirements change with shifts in unit missions, the nature of the threat, and battlefield conditions anticipated as part of CATS?

(3) What kind of training guidance do you see emerging associated with CATS?

- oo Probe for departures from/extensions of 25-100 principles
- oo Probe for emerging training tactics, training techniques and training procedures

(4) Do you see other high priority training needs in the command and control area which may currently exist and will continue to be important as CATS is implemented?

Center for Army Lessons Learned:

(1) Based on your experiences and observations in Desert Storm, what do you see as high priority training needs in the area of command and control?

- oo Probe for echelon (Battalion and below)
- oo Probe for position (e.g., Battalion Commander)

(2) What impact do you see automated command and control devices (such as MCS) exerting on command and control?

- oo Probe for position (e.g., Battalion Commander)
- oo Probe for changes in how job is performed (i.e., new skill requirements)
- oo Probe for anticipated training requirements
- oo Probe for specific problems in information handling, transmission, overload

(3) Were leaders observed in Desert Storm who excelled in command & control? What distinguished them from their less able counterparts? Did their training play a role?

(4) Any other lessons learned which might be useful to us as we plan our research program?

Battalion and Brigade Division, National Simulation Center:

(1) What kinds of command and control activities do you routinely observe? What are the high priority training needs in this area?

- oo Probe for echelon (Battalion and below)
- oo Probe for position (e.g., Battalion Commander)

(2) What kinds of problems have you observed in the use of automated command and control devices such as MCS? Do you see specific training requirements emerging from the use of such devices?

(3) What types of training strategies would help strengthen performance in these areas?

(4) How could command and control training needs be productively addressed in a simulation networking environment?

(5) Are there any training strategies currently being used by your group, particularly using automation (such as PANTHER) that would be useful for us to see?

Tactical Commanders Development Course, School for Command Preparation, CGSC:

(1) What do you see as high priority training needs in the area of command and control for battalion commanders?

(2) What types of innovative approaches have been used successfully in TCDC to address some of these needs?

(3) When the ADST Simulation Networking facility at Fort Leavenworth is fielded, how might you see it being used to train battalion commanders in command and control skills?

(4) Are there any training strategies currently being used at TCDC, particularly using automation, that would be useful for us to see?

Future Battle Lab, CAC-CD:

(1) What do you see as emerging technology in the area of command and control training?

oo Probe for echelon (Battalion and below)
oo Probe for position (e.g., Battalion Commander)

(2) What impact do you see automated command and control devices (such as MCS) exerting on command and control?

oo Probe for position (e.g., Battalion Commander)
oo Probe for changes in how job is performed (i.e., new skill requirements)
oo Probe for anticipated training requirements
oo Probe for specific problems in information handling, transmission, overload

(3) How do you see technology assisting commanders in the command and control process in the future? What training requirements do you anticipate emerging with the use of this technology?

(4) Are there any technology-based devices or automation-based training strategies currently under development at FBL that would be useful for us to see?

School of Advanced Military Studies, CGSC:

(1) What kinds of command and control deficiencies do you routinely observe in SAMS exercises? What are the high priority training needs in this area?

oo Probe for echelon (Battalion)
oo Probe for position (e.g., Battalion Commander)

(2) What kinds of problems have you observed in the use of automated command and control devices such as MCS? Do you see specific training requirements emerging from the use of such devices?

(3) What types of training strategies would help strengthen performance in these areas?

(4) When the ADST Simulation Networking facility at Fort Leavenworth is fielded, how might you see it being used to train SAMS students in command and control skills?

(5) Are there any training strategies currently being used at SAMS, particularly using automation, that would be useful for us to see?